K&S ENGINEERING
Planning Engineering Surveying

STORMWATER MANAGEMENT AND MAINTENANCE PLAN

For

HOLLAND-ROARK SUBDIVISION
Proctor Valley Road
Bonita, CA

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K&S Job #03-069

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INTRODUCTION

The Stormwater Management and Maintenance Plan (SWMP) is required under the County of San Diego Watershed Protection, Stormwater Management, and Discharge Control Ordinance (Section 67.817).

The purpose of this SWMP is to address the water quality impacts from the proposed driveway grading improvements for the Holland-Roark Subdivision (Project) at 3645 Proctor Valley Road in the Bonita area east of Chula Vista. This is an unincorporated part of San Diego County.

Utilization of the best available Best Management Practices (BMPs) will help to provide a long-term solution to water quality. This SWMP also intends to ensure the effectiveness of the BMPs through proper maintenance based on long-term fiscal planning.

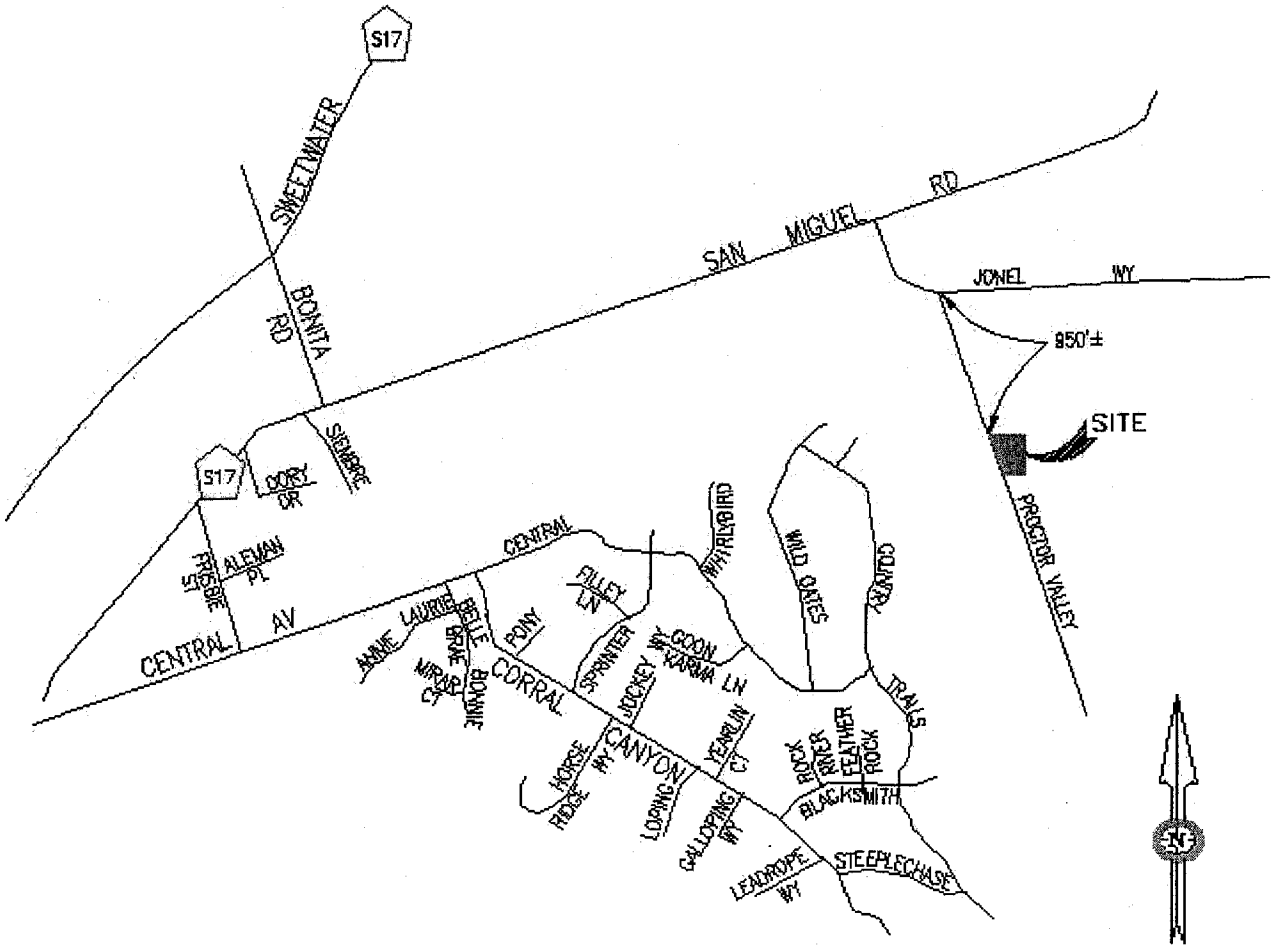
The SWMP is subject to revisions as needed by the engineer.

1.0 PROJECT DESCRIPTION

The subject site consists of 2.94± acres of land with one home located on the southerly portion of the existing lot and is located southeasterly of the intersection of San Miguel Road and Jonel Way. Currently the site contains 2400± square feet of impervious surfaces comprised of the driveway, house walkways and patio areas.

The Project intends to subdivide the single lot into three residential parcels. Each parcel will be a minimum of one acre net area. New driveway approaches will be constructed to access the new parcels. The 2:1 slopes proposed to create these driveways will be seeded and planted as to control erosion. There are no final building plans for the individual parcels at this time and pad access driveways will have an asphalt surface. The driveways will have biofilters swales parallel to their lengths to provide stormwater run-off treatment. The Project will result in a slight increase in impervious area to a total of 3700± square feet.

Figure 1



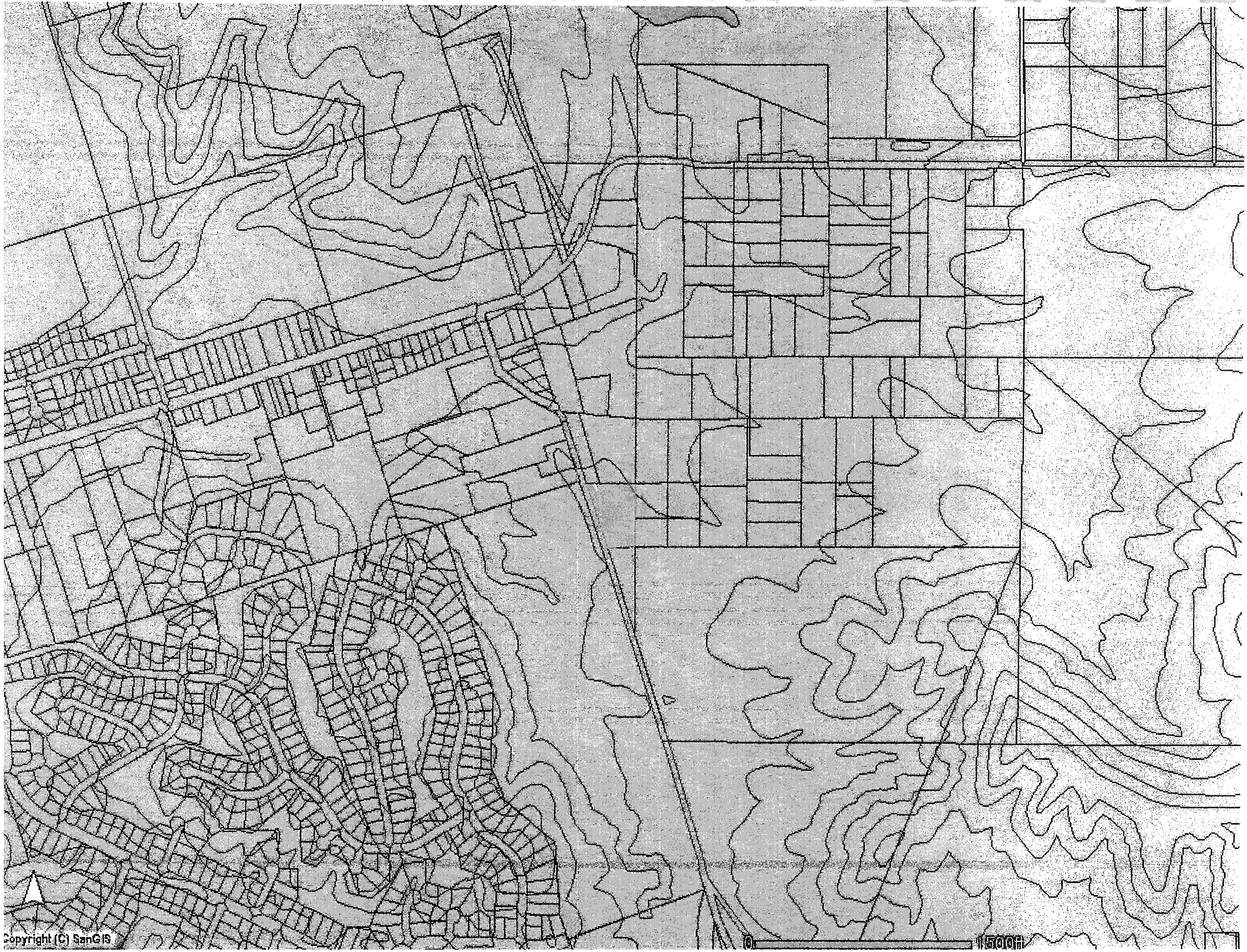
LOCATION MAP
NOT TO SCALE

1.1 Topography and Land Use

The Project is located on a hilltop crest and currently drains in all directions. The driveway locations drain westerly to Proctor Valley Road and then northerly along the same roadway Currently the site is comprised of natural topography with slopes up to and including 15% gradient occupying 60% of the site. Slopes from 15% to 25% gradient comprise 24% of the site and slopes of 25% to 50% comprise 16% of the site. The development of the driveways is located on the western portion of the project, where grading will take place in areas of 25% to 50% gradient. The driveways will have a gradient of 14% from the pad areas towards Proctor Valley Road.. The project will maintain the same overall drainage path after grading improvements.

Natural vegetation located on the site is predominantly composed of annual grasses, chamise-redshank chaparral and some scattered trees. Preservation of existing vegetation located outside of graded areas is a major part of this plan. The graded areas are situated so that large existing trees are not disturbed and are predominantly located in grassy areas.

The current zoning for the Project is RR1, Rural Residential.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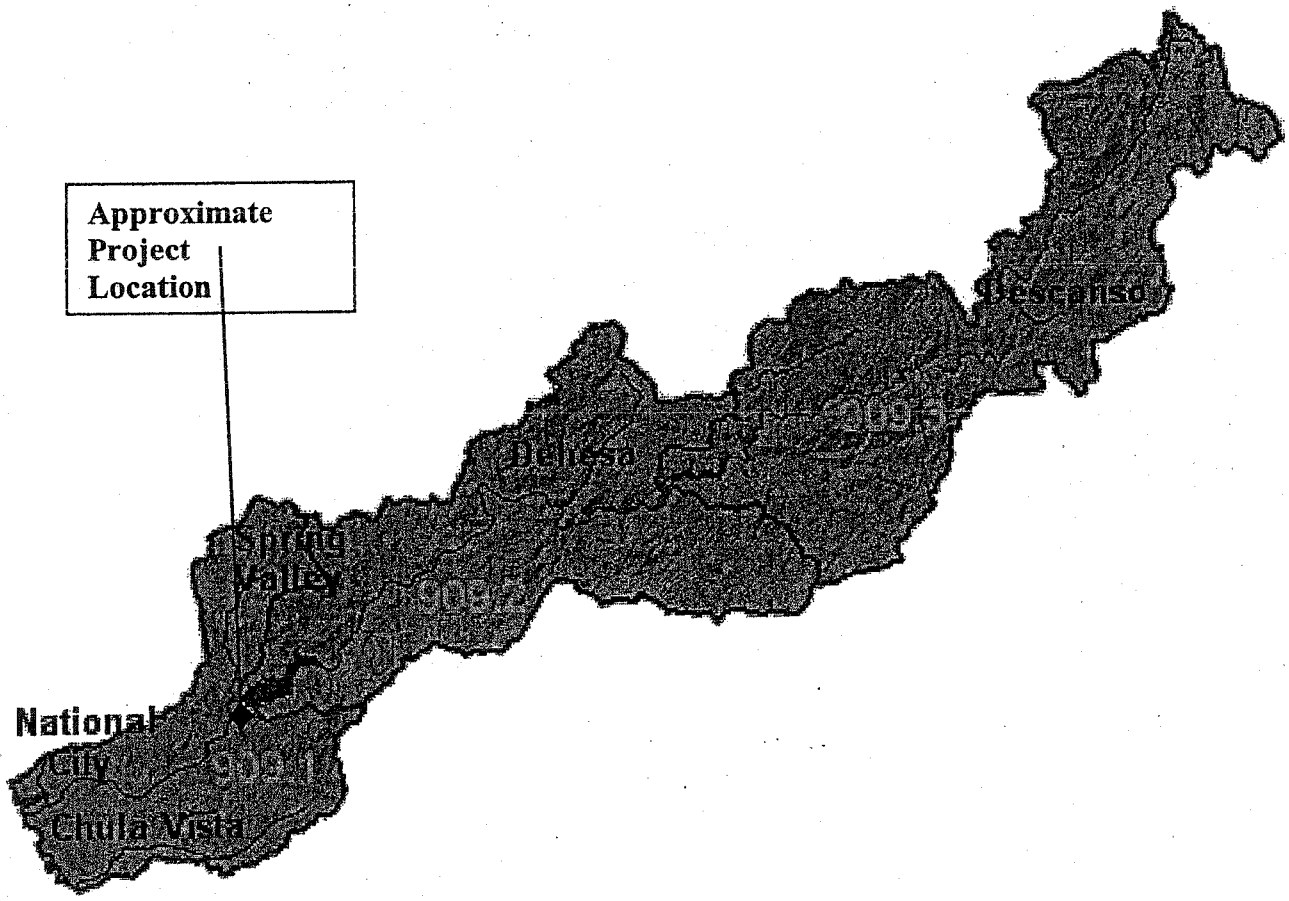
1.2 Hydrologic Unit Contribution

The project is located in the La Nacion hydrologic subarea (HAS) (909.12) of the Lower Sweetwater hydrologic area (HA) of the Sweetwater River Watershed hydrologic unit (HU). The project is characterized by gently to moderately to steeply sloping terrain. The project is a small part of the watershed and contains a projected 1300 square feet of graded area. The drainage for this project will eventually flow into the Sweetwater River before emptying into San Diego Bay before entering the Pacific Ocean. The Sweetwater River watershed combines the Otay and the Puebla San Diego Watersheds to form the San Diego Bay Watershed area. The Sweetwater HU comprises 230 square miles of the approximately 415 square miles of the San Diego Bay Watershed area.

The proposed project will not alter the overall drainage pattern at the outfall of the drainage system. As the site is currently undeveloped, except for the existing roadway areas within the parcel, a modest increase in impervious area will be experienced by the ultimate project development.

According to the County of San Diego Hydrology Manual, September 2002, considers the existing and proposed conditions as low density residential of one dwelling unit per acre or less. Therefore, no increase in the Runoff Coefficient occurs.

Figure 3



SWEETWATER HYDROLOGIC UNIT

2.0 WATER QUALITY ENVIRONMENT

2.1 Beneficial Use

The beneficial uses of inland surface water, coastal waters, reservoirs & lakes and groundwater for this hydrologic unit are included in Table 1. The data contained in this Table is extracted from the Water Quality Control Plan for the San Diego Basin.

TABLE 1
Beneficial Uses

Beneficial Uses	Inland Surface Water	Coastal Waters	Reservoirs and Lakes	Ground Water
Municipal and Domestic Supply	x		x	x
Agricultural Supply	x		x	x
Industrial Service Supply	x	x	x	x
Industrial Process Supply	x		x	
Navigation		x		
Contact Water Recreation	x	x	x	
Non-Contact Water Recreation	x	x	x	
Commercial and Sport Fishing		x		
Biological Habitats of Special Significance	x	x		
Warm Freshwater Habitat	x		x	
Cold Freshwater Habitat	x		x	
Wildlife Habitat	x	x	x	
Rare, Threatened, or Endangered	x	x		
Marine Habitat		x		
Migration of Aquatic Organisms		x		
Estuarine Habitat		x		
Shellfish Harvesting		x		

The reader is directed to the Water Quality Control Plan for the San Diego River Basin for more detailed descriptions of the above beneficial uses.

2.2 303(d) Status

According to the California 2002 303(d) list, published by the San Diego Regional Water Quality Control Board, there are no impaired waterbodies associated with this project.

The project location and watersheds have been compared to the current published 303d list of impaired water bodies and the nearest impaired water body within the HU is the San Diego Bay shoreline at the Chula Vista Marina. Impairment for this area of San Diego Bay shoreline is limited to bacteria indicators. The Project is approximately 15 miles upstream along the Sweetwater River and Harbison Canyon tributary from the Sweetwater Reservoir and 25 miles upstream from San Diego Bay.

3.0 CHARACTERIZATION OF PROJECT RUNOFF

As identified above, the San Diego Bay area near the Chula Vista Marina is the only impaired waterbody identified on the 303(d) list.

The mouth of the Sweetwater River discharges into the San Diego Bay at the border of the communities of Chula Vista and National City. Beach postings and closures from elevated levels of coliform bacteria more than doubled between 1996 and 1999 due to urban runoff and sewage spills. Discharge from the Sweetwater River outlet may also influence water quality in other nearby coastal areas including Coronado, Imperial Beach, and San Diego. The extensive groundwater resources beneath the Sweetwater River provide a cost effective and reliable water supply to four local water districts. Excessive extraction, increasing total dissolved solids and MTBE contamination now threatens this resource.

The Project is approximately 25 miles upstream from the Bay. Natural and man-made ponds, depressions and wetlands in the Sweetwater River will provide additional opportunity for settlement and biodegradation of runoff constituents from the project area.

3.1 Constituents of Concern and Sources

There are no sampling data available for the existing site condition. In addition, the project is not expected to generate significant amounts of non-visible pollutants. However, the Table 2 shows constituents commonly found on similar developments and could affect water quality:

TABLE 2

Pollutants from the Project Area

	General Pollutant Categories								
Priority Project Categories	Sediments	Nutrients	Heavy Metals	Organic Compounds	Trash & Debris	Oxygen Demanding Substances	Oil & Grease	Bacteria & Viruses	Pesticides
Detached Residential Development	X	X			X	X		X	X

The following categories of pollutants as identified in Table 2 shall be evaluated as potential pollutants of concern:

- Sediments – Sediments are soils or other surficial materials eroded and then transported or deposited by the action of wind, water, ice, or gravity. Sediments can increase turbidity, clog fish gills, reduce spawning habitat, lower young aquatic organisms survival rates, smother bottom dwelling organisms, and suppress aquatic vegetation growth.
- Nutrients – Nutrients are inorganic substances, such as nitrogen and phosphorus. They commonly exist in the form of mineral salts that are either dissolved or suspended in water. Primary sources of nutrients in urban runoff are fertilizers and eroded soils. Excessive discharge of nutrients to water bodies and streams can cause excessive aquatic algae and plant growth. Such excessive production, referred to as cultural eutrophication, may lead to excessive

decay of organic matter in the water body, loss of oxygen in the water, release of toxins in sediment, and the eventual death of aquatic organisms.

- Trash & Debris – Trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic matter (such as leaves, grass cuttings, and food waste) are general waste products on the landscape. The presence of trash & debris may have a significant impact on the recreational value of a water body and aquatic habitat. Excess organic matter can create a high biochemical oxygen demand in a stream and thereby lower its water quality. Additionally, in areas where stagnant water exists, the presence of excess organic matter can promote septic conditions resulting in the growth of undesirable organisms and the release of odorous and hazardous compounds such as hydrogen sulfide.
- Oxygen-Demanding Substances – This category includes biodegradable organic material as well as chemicals that react with dissolved oxygen in water to form other compounds. Proteins, carbohydrates, and fats are examples of biodegradable organic compounds. Compounds such as ammonia and hydrogen sulfide are examples of oxygen-demanding compounds. The oxygen demand of a substance can lead to depletion of dissolved oxygen in a water body and possibly the development of septic conditions.
- Bacteria and Viruses – Bacteria and viruses are ubiquitous microorganisms that thrive under certain environmental conditions. Their proliferation is typically caused by the transport of animal or human fecal wastes from the watershed. Water, containing excessive bacteria and viruses can alter the aquatic habitat and create a harmful environment for humans and aquatic life. In addition, the decomposition of excess organic waste causes increased growth of undesirable organisms in the water.
- Pesticides – Pesticides (including herbicides) are chemical compounds commonly used to control nuisance growth or prevalence of organisms. Excessive application of a pesticide may result in runoff containing toxic levels of its active component.

3.2 Soil Characteristics

The project area consists of soil group D. Soils in this group have a very slow infiltration rate when thoroughly wetted; chiefly clays that have a high shrink-swell potential, soils that have a high permanent water table, soils that have a claypan or clay layer at or near the surface, or soils that are shallow over nearly impervious material. Rate of water transmission is very slow.

4.0 MITIGATIVE MEASURES TO PROTECT WATER QUALITY

To address water quality for the project, BMPs will be implemented during construction and post construction phases.

4.1 Construction BMPs

A detailed description of the construction BMPs will be developed during the Grading Plan and Improvement Plan engineering. Since the project is in the preliminary development phase only a listing of potential types of temporary BMPs are available. Potential temporary BMPs include the following:

- Scheduling.
- Preservation of Exiting Vegetation.
- Minimize Disturbance and Buffer Strips.
- Land Grading and Minimize Erosion.
- Silt Fences.
- Stockpile Management.
- Solid Waste Management.
- Stabilized Construction Entrance/Exit.
- Vehicle and Equipment Maintenance.
- Gravel Bag Barrier.
- Material Delivery and Storage.
- Spill Prevention and Control.
- Concrete Waste Management.
- Water Conservation Practices.
- Stabilization of Disturbed Areas.

Construction BMPs for this project will be selected, constructed, and maintained to comply with all applicable ordinances and guidance documents.

See Appendix A.

4.2 Post-construction BMPs

The project is designed to minimize the use of impervious areas. Landscaping of the slope areas will be incorporated into the project plans.

The landscaping will consist of ornamental plantings and ground covers including turfed areas to provide bio-filtration of storm and non-storm runoff. The goal is to achieve plant establishment expeditiously to reduce erosion. The irrigation system for these landscape areas will be installed and monitored to reduce over-irrigation.

A public education and landscape management plan will be incorporated into the project. The elements of the plan may consist of public awareness signs, and herbicide/pesticide management.

Post Construction BMPs include, but are not limited to the following:

- Biofilters
- Slope Seeding and Planting.
- Mulching.

See Appendix B

4.2.1 Bio-Filters

Bio-filter swales are vegetated channels that receive directed flow and convey storm water. Bio-filtration strips, also known as vegetated buffer strips, are vegetated sections of land over which storm water flows as overland sheet flow. Landscaped and turfed areas on individual lots areas will serve as bio-filter swales in the subject subdivision project.

Pollutants are removed by sedimentation, filtration through the grass, adsorption to soil particles, and infiltration through the soil. Swales and strips are mainly effective at removing debris and solid particles, although some dissolved constituents are removed by adsorption onto the soil.

5.0 OPERATION AND MAINTENANCE PROGRAM

The operation and maintenance needs of bio-filters are:

- Vegetation and management to maintain adequate hydraulic functioning and to limit habitat for disease-carrying animals.
- Animal and vector control.
- Periodic sediment removal to optimize performance.
- Removal of trash, debris, grass trimmings, tree pruning, and leaf collection to prevent obstruction of swales.
- Removal of standing water, which may contribute to the development of aquatic plant communities or mosquito breeding areas.
- Erosion and structural maintenance to prevent the loss of soil and maintain the performance of the swales.

5.1 Inspection frequency

Bio-filters should be inspected at the following times:

- Once a month at a minimum.
- After every runoff producing storm.
- On a weekly basis during extended periods of in climate weather.

5.2 Preventive Maintenance

Preventive maintenance activities for bio-filter swales are:

- Grass Mowing. — Vegetation seed mix or sod within the bio-filter will be designed to be kept short to maintain adequate hydraulic function and to limit the development of faunal habitats.
- Trash and Debris. Debris and trash removal will be conducted to reduce the potential for inlet and outlet structures and other components from becoming clogged and inoperable during storm events.
- Sediment Removal. Sediment accumulation, as part of the operation and maintenance program for swales, should be monitored once a month during the dry season, after every large storm, and at least monthly during the rainy season, October 1 to April 30. Specifically, if sediment reaches a level at or near plant height, or could interfere with flow or operation, the sediment will be removed. If accumulation of debris or sediment is determined to be the cause of decline in design performance, prompt action (i.e., within ten working days) should be taken to restore the swale to design performance standards. Actions will include using additional fill and vegetation and/or removing accumulated sediment to correct channeling or ponding.
- Characterization and appropriate disposal of sediment will comply with applicable local, county, state, or federal requirements. The swale will be re-graded, if the flow gradient has changed, and then replanted with appropriate vegetation.
- Removal of Standing Water. Standing water must be removed if it contributes to the development of aquatic plant communities or mosquito breeding areas.
- Use and Application of Fertilizers, Herbicides and Pesticides. The application of these materials should be in strict conformance with the manufacturers' instructions and care should be taken not to over-apply.

5.3 Corrective Maintenance

- Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of a Swale. Corrective maintenance activities include:

- Removal of Debris and Sediment. Sediment, debris, and trash, which impede the hydraulic functioning of swales and prevent vegetative growth, will be removed and properly disposed. Temporary arrangements will be made for handling the sediments until a permanent arrangement is made. Vegetation will be reestablished after sediment removal.
- Structural Repairs. Once deemed necessary, repairs to bio-filters should be performed within 10 working days.
- Embankment and Slope Repairs. Once deemed necessary, damage to the embankments and slopes upstream of swales should be repaired within 10 working days.
- Erosion Repair. Where a reseeding program has been ineffective, or where other factors have created erosive conditions (i.e. pedestrian traffic, concentrated flow, etc.), corrective steps will be taken to prevent loss of soil and any subsequent danger to the performance of the bio-filter. There are a number of corrective actions than can be taken which include erosion control blankets, riprap, sodding, or reduced flow through the affected area.

Table 3
BMP Maintenance Schedule

A schedule of periodic maintenance should be implemented and modified as needed to insure effective operation of the indicated BMP's. As a guideline, a tentative schedule of maintenance frequency follows. The schedule is based on certain indicators outlined for a particular BMP.

BMP	INDICATORS	FREQUENCY
Silt Fence	Fence is not upright or has been breached.	Inspect weekly and after rainfall. Repair as required. Remove sediment when 1/3 height of fence.
Slope Irrigation	Slope plantings not growing.	Inspect weekly for non-operation during dry season, Monthly during rainy season.
Mulching/Hydroseeding	Bare patches.	Inspect weekly and after rainfall for damage or deterioration

6.0 FISCAL RESOURCES

Construction, installation and maintenance of the post- development BMPs will be the responsibility of the project developer under a BMP Maintenance Agreement with the County. A security will be required to back-up the Maintenance Agreement to equal the cost of two years maintenance activities and the agreement will remain in place for an interim period of five years. The permanent responsibility of the post-development BMPs will be outlined in the final covenants, codes and restrictions (CC&R's) for the development. Individual property owners will be responsible for their respective properties. The responsibility to perform landscape maintenance to permanently stabilize graded areas will lie with the same entities.

Most of the post-construction BMPs accrue minimal maintenance costs. Mulching, slope seeding and plantings are maintained as part of continuing landscape maintenance through the project developer and the individual property owners. Landscape Maintenance to permanently stabilize graded areas will be the responsibility of the individual property owners.

Table 4
BMP Estimated Construction Costs

Construction and postconstruction BMP's for this project comply with all applicable ordinances and guidance documents. Costs are based upon County of San Diego DPW unit price list, project cost estimates, industry supply sources and field experience. Below are the itemized installation costs of the project BMP's as shown in Figure I.

Temporary construction BMP's can be implemented on an as needed basis during construction. Variable conditions and situations dictate the chosen BMP and that choice cannot be foreseen, therefore, they cannot be itemized.

Construction and post construction BMP costs include, but are not limited to the following:

BMP CONSTRUCTION COSTS				
BMP ITEM	QTY.	UNIT	UNIT COST	BMP COST
SILT FENCE	60	LF	$1.60	$96.00
SLOPE IRRIGATION (PER 1000 SF)	0.5	SF	$585.00	$292.50
MULCHING/HYDROSEEDING	800	SF	$0.20	$160.00
			TOTAL	$548.50

Table 5
BMP Estimated Maintenance Costs

BMP construction for this project will nessecitate continuous operation and maintenance during construction and when the project is complete. O&M costs are based upon California Department of Transportation estimated costs for pilot BMP project utilizing prevailing wage rates. Below are the itemized costs, based on prevailing wage rates, of the project BMP's as shown in Figure I.

As identified in SWMP Section 6.0, Fiscal Resources, the source for funding of BMP operation and maintenance are contained in the final deed CC&R's for the project and individual lots.

Construction and post construction BMP operation and maintenance costs include, but are not limited to the following:

BMP OPERATION & MAINTENANCE COSTS

BMP OPERATION & MAINTENANCE ITEM	LABOR			EQUIPMENT				MATERIALS		TOTAL COST
	Per Hrs.	Rate	Cost	Type	Days	Rate	Cost	Item	Cost	
SILT FENCE	10.0	43.63	$436.30	1 Ton Truck	2.0	26.84	$53.68	Silt Fencing, Posts, Shovels	$100.00	$589.98
SLOPE IRRIGATION (PER 1000 SF)	15.0	43.63	$654.45	1 Ton Truck	1.0	26.84	$26.84	A/R Pipes, Valves	$50.00	$731.29
MULCHING/HYDROSEEDING	4.0	43.63	$174.52	Hydroseeder, 1 Ton Truck	2.0	48.15	$96.30	Seed, Binder	$100.00	$370.82
									O&M TOTAL	**$1,692.09**

7.0 CONCLUSION

This SWMP has been prepared to define potential Best Management Practices (BMPs) that satisfy the requirements identified in the following documents:

1) County of San Diego Watershed Protection Stormwater Management and Discharge Control Ordinance (Section 67.817).
2) Standard Specifications for Public Works Construction.
3) NPDES General Permit for Storm Water Discharges Associated with Construction Activity issued by the State Water Resources Control Board.
4) San Diego NPDES Municipal Storm Water Permit (Order Number 2001-01).

Thus, it has been shown that this project can meet the water quality objectives as outlined in Order 2001-01 as proposed and shown on the site plan. An analysis has been performed to ensure that the site plan can accommodate the water quality BMPs. Therefore, it is anticipated that the site plan will not affect downstream waters by the implementation of these BMPs.

CERTIFICATION

This Stormwater Management and Maintenance Plan has been prepared under the direction of the undersigned.

8/15/03

Hossein Zomorrodi, R.C.E. 43235 Date

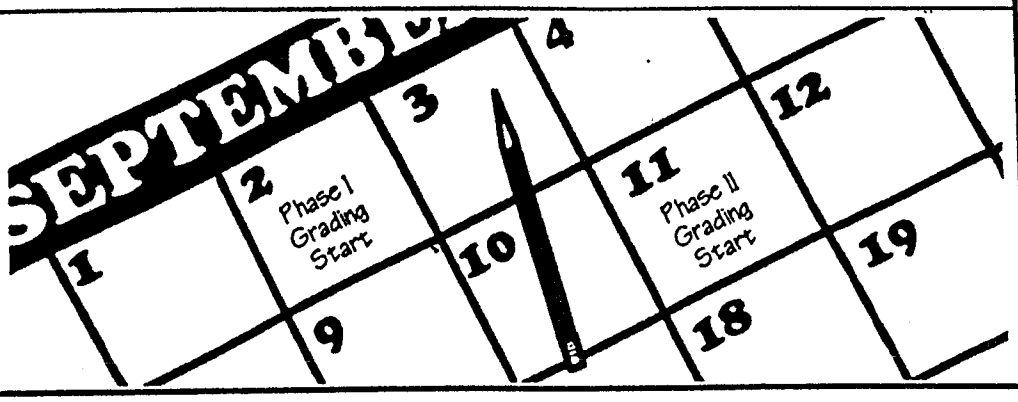
ATTACHMENTS

SITE MAP

APPENDIX A

CONSTRUCTION BMPS

BMP: SCHEDULING



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Sequencing the construction project to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

SUITABLE APPLICATIONS

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project. Use of other, more costly yet less effective, erosion and sedimentation controls, may often be reduced through proper construction sequencing.

APPROACH

- Project design considerations: Design project to integrate into existing land contours. Significant regrading of a site will require more costly erosion and sedimentation control measures and may require that on-site drainage facilities be installed.
- Incorporate existing, natural areas: Inventory and evaluate the existing site terrain and vegetation. Disturbance of highly erosive natural areas (e.g., steep, unstable slope areas, watercourses) should be minimized, while protecting other areas may enhance site aesthetics. Construction should not disturb these areas (see ESC2).
- Avoid rainy periods: Schedule major grading operations during dry months. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means (see ESC 10 to 24) or to install temporary sediment trapping devices (see ESC 50 to 56).
- Practice erosion and sediment control year round: Erosion may be caused during dry seasons by "freak" rainfall, wind and vehicle tracking. Therefore, keep the site stabilized year-round, and retain wet season sediment trapping devices.
- Minimize soil exposed at one time: Schedule projects to disturb only small portions of the site at any one time. Complete grading as soon as possible. Immediately stabilize the disturbed portion before grading the next portion. Practice staged seeding—revegetate cut and fill slopes as the work progresses.
- Trenching: Close and stabilize open trenches as soon as possible. Sequence trenching projects so that most open portions of the trench are closed before new trenching is begun.

REQUIREMENTS

- Cost
  - Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost-effectiveness of scheduling techniques should be compared with the other, less effective erosion and sedimentation controls to achieve a cost-effective balance.

Targeted Pollutants

- ○ Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ○ Training
- ○ Suitibility for Slopes >5%

● High ○ Low

ESC1

Best Management Practices

LIMITATIONS

There are no significant limitations to the use of this BMP.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona - 1992.

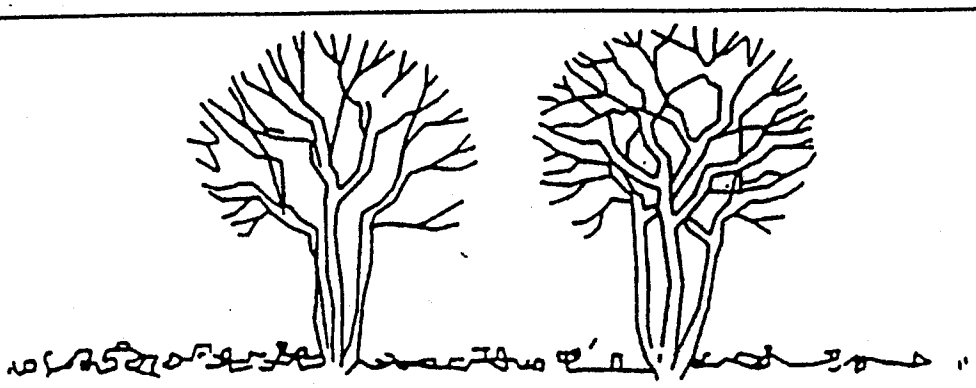
Erosion and Sediment Control Guidelines for Developing Areas in Texas, U.S. Department of Agriculture, Soil Conservation Service, Fort Worth, Texas - 1976.

Storm Water Management for Construction Activites. Developing Pollution Prevention Plans and Best Management Practices, U.S. Environmental Protection Agency, Office of Water (EPA 832-R-92-005) - September, 1992.

Virginia Erosion and Sediment Control Handbook, Third Edition, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation - 1992.

ESC1

BMP: PRESERVATION OF EXISTING VEGETATION



Objectives

Housekeeping Practices

Contain Waste

Minimize Disturbed Areas

Stabilize Disturbed Areas

Protect Slopes/Channels

Control Site Perimeter

Control Internal Erosion

GENERAL DESCRIPTION

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs and/or grasses that serve as erosion controls.

SUITABLE APPLICATIONS

- Areas within site where no construction activity occurs, or occurs at a later date.
- Sensitive areas where natural vegetation exist and should be preserved, such as: steep slopes, watercourses, and building sites in wooded areas.
- Areas where local, state and federal government requires preservation, such as: vernal pools, wetlands, marshes, certain oak trees, etc.

INSTALLATION/APPLICATION CRITERIA

- Clearly mark, flag or fence vegetation or areas where vegetation should be preserved.
- Prepare landscaping plans which include as much existing vegetation as possible and state proper care of this vegetation both during and after construction.
- Define and protect with berms, fencing, signs, etc., a setback area from vegetation to be preserved. Setback area size should be based on the location, species, size, age and potential impact of adjacent construction activities or permanent improvements.
- Proposed landscaping plans which do not include plant species that compete with the existing vegetation.
- Do not locate construction traffic routes, spoil piles, etc., where significant adverse impact on existing vegetation may occur.

REQUIREMENTS

- Maintenance
  - Inspection and maintenance requirements for protection of vegetation are low.
  - During construction the limits of grading or disturbance should be clearly marked at all times.
  - Irrigation or maintenance of native trees or vegetation should conform to specifications on the Landscape Plan.
- Cost
  - There is little cost associated with preserving existing vegetation if properly planned during the project design, and may yield aesthetic benefits which enhance property values.

LIMITATIONS

- Requires forward planning by the owner/developer, contractor and design staff.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactorily for the planned development.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ○ *Maintenance*
- ○ *Training*
- ● *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC2

Best Management Practices

Additional Information — Preservation of Existing Vegetation

The best way to prevent excessive erosion is to not disturb the land. On a construction site, where extensive land disturbance is necessary, a reasonable BMP would be to not disturb land in sensitive areas of the site which need not be altered for the project to be viable (e.g., natural watercourses, steep slopes), and to design the site to incorporate particularly unique or desireable existing vegetation into the site landscaping plan. Clearly marking and leaving a buffer area around these unique areas will both help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping in naturally vegetated areas.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to insure the survival of desirable vegetation for shade, beautification, and erosion protection. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. Also, vegetation helps to keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

The following criteria may be used for deciding which vegetation will remain on the site:

- Aesthetic values: Consideration should be given to foliage, flowering habits, bark and crown characteristics (for trees).
- Freedom from disease and rot.
- Life span of trees: Short-lived trees need not be preserved.
- Environmental values: Habitat; screening; and buffers.
- Sudden exposure: Save vegetation which grows in direct sunlight and is able to withstand radiated heat from proposed buildings and pavement.
- Space needed: Sufficient space must be provided between the vegetation and any structures, electric and telephone lines, water and sewer lines, driveways and streets. Mark trees and shrubs with bright paint or ribbon so there is no doubt as to which trees and shrubs are to be left and protected from damage during construction.

Saving existing vegetation and mature trees on-site, beautifies the area and may save money by reducing new landscaping requirements. Mature trees also increase property values and satisfy consumer aesthetic needs.

Preserving and protecting existing vegetation can often result in more stable soil conditions during construction. Careful site planning and identification of plantings to preserve can provide erosion and sedimentation controls during construction, and contribute to the aesthetics of the development. For example, in Sacramento County a tree ordinance has been adopted that protects the native California Oak tree. Provisions to protect the tree and its root system during construction must be specified in the project plans, and an area must be provided where the soil stability may not be disturbed. No grading or construction storage within the tree dripline is allowed.

Installation/Application

Building sites may be planned to integrate existing vegetation and trees. Construction impacts must be considered. Trench width for pipe construction projects and the location of permanent structures, such as buildings, needs to be considered when preserving existing vegetation, including mature trees and their root system. Native vegetation should be preserved since it is able to adapt to the climate. The USDA Soil Conservation Service should be contacted about existing vegetation for sites throughout California. Mature trees are generally preferable to newly planted trees because of the greater soil stabilization provided by the extensive root system of a mature tree.

ESC2

Additional Information — Preservation of Existing Vegetation

Methods for protecting existing vegetation and trees:

- Stake off root system limits (drip line of tree). Some counties limit construction within 5 feet of the tree drip line.
- Fence off the area to be preserved or along the tree drip line.
- Flag or mark trees to remain in place.
- Tree wells and retaining walls (permanent) help preserve existing vegetation, but must be large enough to protect the root system (see below).
- For the California Oak tree, no trenching or irrigation should be allowed within the driplines of the tree, since both these activities are detrimental to the preservation of the tree.
- Where grading under trees is necessary, excavation and fill should be limited to 1 foot within the driplines.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

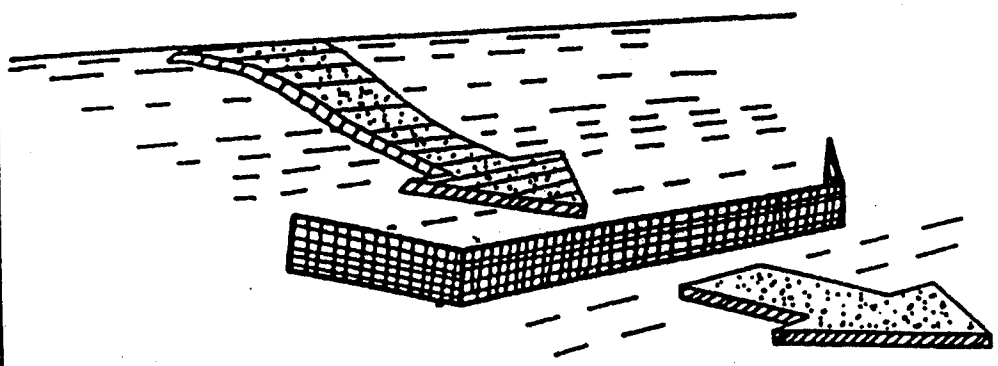
County of Sacramento Tree Preservation Ordinance - September 1981.

Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC2

BMP: SILT FENCE



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DESCRIPTION

A silt fence is made of a filter fabric which has been entrenched, attached to supporting poles, and sometimes backed by a wire fence for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

SUITABLE APPLICATIONS

- Along the perimeter of the site.
- Below the toe of a cleared slope.
- Along streams and channels.
- Around temporary spoil areas.
- Across swales with catchments less than 1 acre.
- Below other small cleared areas.

INSTALLATION/APPLICATION

- Use principally in areas where sheet flow occurs.
- Install along a level contour, so water does not pond more than 1.5 feet at any point.
- No more than 1 acre, 100 ft., or 0.5 cfs of concentrated flow should drain to any point along the silt fence.
- Turn ends of fence uphill.
- Provide area behind the fence for runoff to pond and sediment to settle (approx. 1200 sq. ft. per acre draining to the silt fence).
- Select filter fabric which retains 85% of the soil, by weight, based on sieve analysis, but is not finer than an equivalent opening size of 70.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each rainfall.
  - Repair wherever fence is damaged.
  - Remove sediment when it reaches 1/3 the height of the fence.
- Cost (source: EPA, 1992)
  - Average annual cost for installation and maintenance (assumes 6 month useful life): $7 per lineal foot ($850 per drainage acre)

LIMITATIONS

- Do not use where 85% of the soil, by weight, passes through a No. 200 sieve because the filter fabric will clog.
- Do not place fence on a slope, or across any contour line.
- Do not use in streams, channels, or anywhere flow has concentrated.
- Do not use in locations where ponded water may cause flooding.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC50

Best Management Practices

Additional Information — Silt Fence

To reduce the chance of clogging, it is preferable to specify a fabric with openings as large as allowed by the criteria. No fabric should be specified with an EOS smaller than U.S. Standard Sieve No. 100 [0.0059 in. (0.15 mm.)]. If 85 percent or more of a soil, by weight, passes through the openings in a No. 200 sieve [0.0029 in. (0.074 mm.)], filter fabric should not be used. Most of the particles in such a soil would not be retained if the EOS was too large, and they would clog the fabric quickly if the EOS was small enough to capture the soil.

The fence should be supported by a wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Filter fabric material should contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0° F. to 120° F.

Installation Guidelines:
Filter fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- Posts should be spaced a maximum of 6 feet apart and driven securely into the ground a minimum of 30 inches.
- A trench should be excavated approximately 8 inches wide and 12 inches deep along the line of posts and upslope from the barrier.
- When standard strength filter fabric is used, a wire mesh support fence should be fastened securely to the upslope side of the posts using heavy-duty wire staples at least 1 inch long, tie wires or hog rings. The wire should extend into the trench a minimum of 4 inches.
- The standard strength filter fabric should be stapled or wired to the fence, and 40 inches of the fabric should extend into the trench. When extra-strength filter fabric and closer post spacing are used, the wire mesh support fence may be eliminated and the filter fabric stapled or wired directly to the posts.
- Avoid the use of joints. The filter fabric should be purchased in a continuous roll, then cut to the length of the barrier. When joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 6 inch overlap, and both ends securely fastened to the post.
- The trench should be backfilled with compacted native material.

Requirements
Maintenance:

Inspect monthly during dry periods and immediately after each rainfall. Repair as necessary. Sediment must be removed when it reaches approximately one third the height of the fence, especially if heavy rains are expected.

Filter fences should not be removed until the upslope area has been permanently stabilized.

Limitations
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence and may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Filter fences are not practical where large flows of water are involved, hence the need to restrict their use to drainage areas of one acre or less, and flow rates of less than 0.5 cfs.
- Problems may arise from incorrect selection of pore size and/or improper installation.
- Do not allow water depth to exceed 1.5 ft. at any point.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.

ESC50

Additional Information — Silt Fence

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September1992.

Environmental Action Manual, City of Austin, Texas, 1989.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, Jun 1981.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April, 1992.

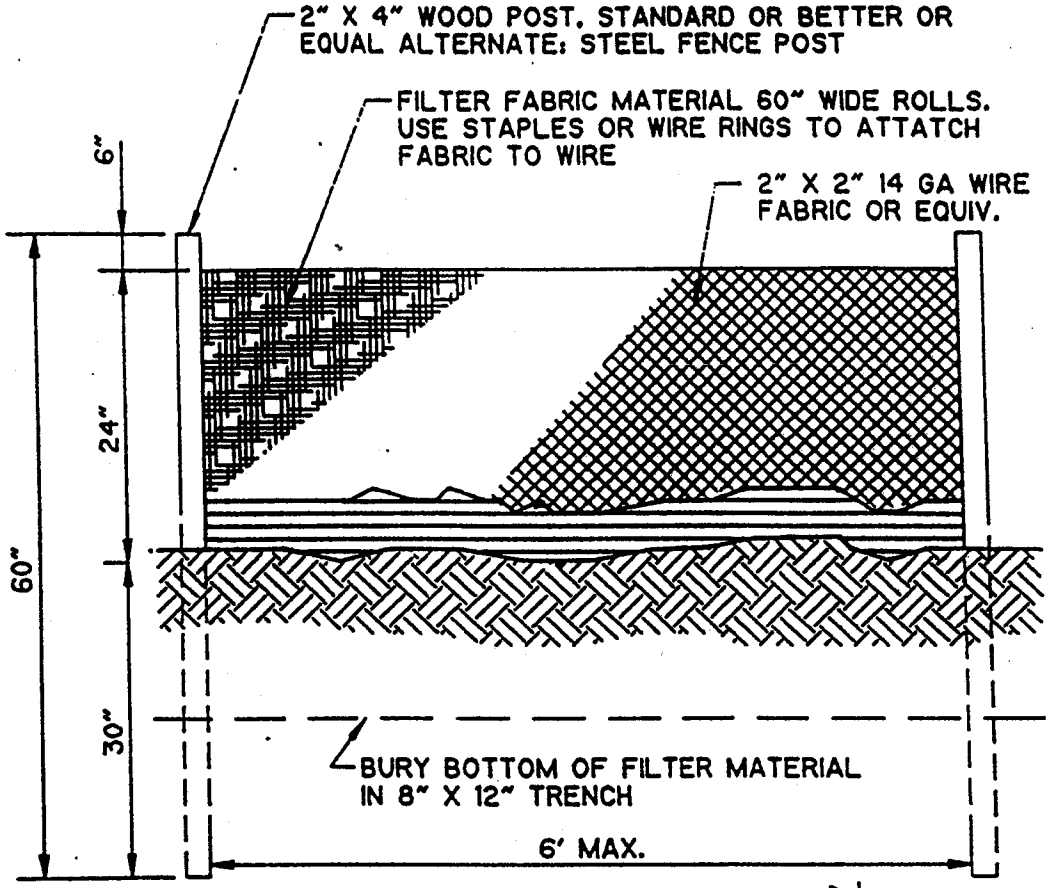
Sedimentation and Erosion Control Practices, An Introductory of Current Practices (Draft), USEPA, 1990.

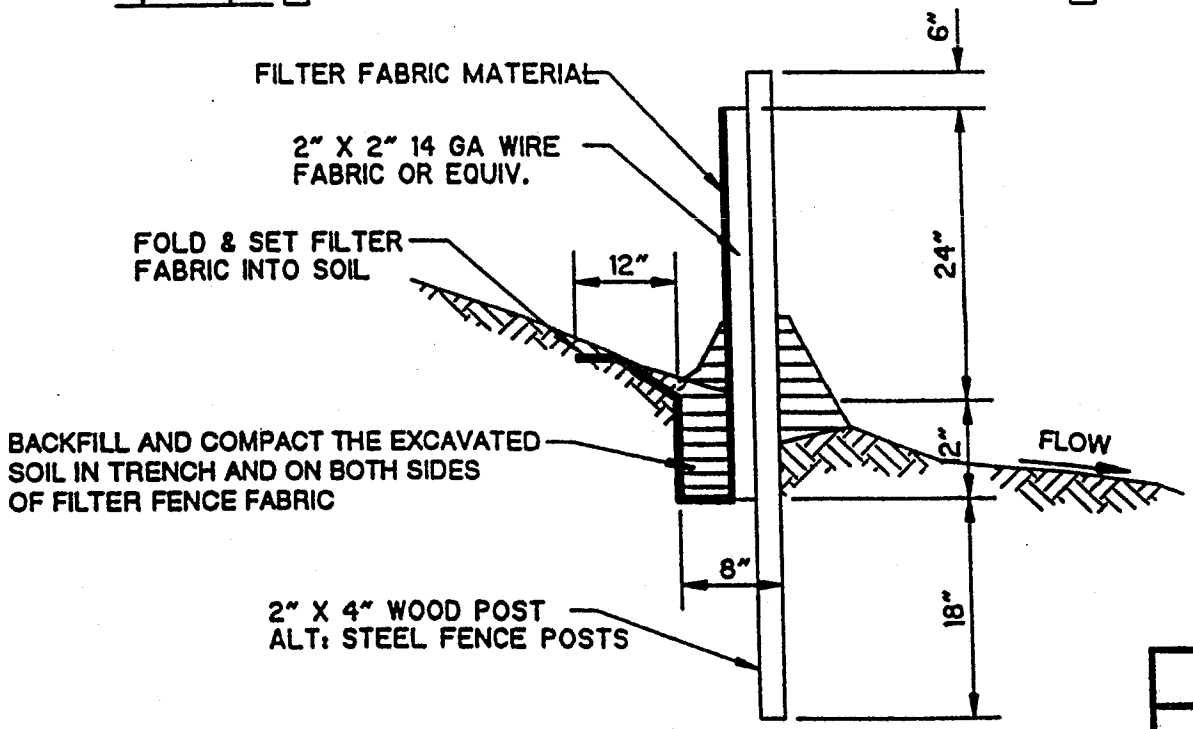
Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC50

Additional Information — Silt Fence



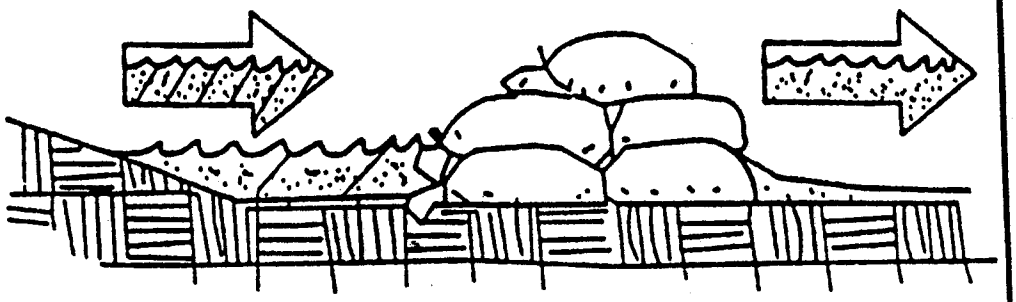


SILT FENCE

ESC50

Best Management Practices

BMP: SAND BAG BARRIER



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- **Protect Slopes/Channels**
- **Control Site Perimeter**
- **Control Internal Erosion**

GENERAL DEFINITION

Stacking sand bags along a level contour creates a barrier which detains sediment-laden water, ponding water upstream of the barrier and promoting sedimentation.

SUITABLE APPLICATIONS

- Along the perimeter of the site.
- Check dams across streams and channels.
- Along streams and channels.
- Barrier for utility trenches in a channel.
- Across swales with small catchments.
- Division dike or berm.
- Below the toe of a cleared slope.
- Create a temporary sediment trap.
- Around temporary spoil areas.
- Below other small cleared areas.

INSTALLATION/APPLICATION CRITERIA

- May be used in drainage areas up to 5 acres.
- Install along a level contour.
- Base of sand bag barrier should be at least 48 inches wide.
- Height of sand bag barrier should be at least 18 inches high.
- 4 inch PVC pipe may be installed between the top layer of sand bags to drain large flood flows.
- Provide area behind barrier for runoff to pond and sediment to settle, size according to sediment trap BMP criteria (ESC55).
- Place <u>below</u> the toe of a slope.
- Use sand bags large enough and sturdy enough to withstand major flooding.

REQUIREMENTS

- Maintenance
  - Inspect after each rain.
  - Reshape or replace damaged sand bags immediately.
  - Remove sediment when it reaches six inches in depth.
- Cost
  - Sand bag barriers are more costly, but typically have a longer useful life than other barriers.

LIMITATIONS

- Sand bags are more expensive than other barriers, but also more durable.
- Burlap should not be used for sand bags.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ● Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ○ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

ESC52

Best Management Practices

Additional Information — Sand Bag Barrier

Suitable Applications

Sand bag berms may be used during construction activities in stream beds and utility construction in channels, temporary channel crossing for construction equipment, etc. Sand bag berms may also be installed parallel to roadway construction. Sand bag berms may also be used to create temporary sediment traps, retention basins and in place of straw bales or silt fences. Examples of applications include:

- Check dams across stream channels.
- Barriers for utility trenches or other construction in a stream channel.
- At temporary channel crossings.
- May be used on a slope where straw bales and silt fences are not appropriate.
- As a diversion dike.
- Embankment for a temporary sediment basin or retention basin.
- Sediment barriers near the toe of slopes.
- At construction perimeter.

Advantages

- Provides a semi-permeable barrier in potentially wet areas.
- More permanent than silt fences or straw bales.
- Allows for easy relocation on site to meet changing needs during construction.

Installation/Application

Sand bag barriers may be used for sediment trapping in locations where silt fences and straw bale barriers are not strong enough. In addition, sand bag barriers are appropriate to use when construction of check dams or sumps in a stream is undesirable. The sand bag berms can provide the same function as a check dam without disturbing the stream or vegetation. The sand bag berm will also allow a small sediment retention area to be created prior to construction of final detention basins. For installation of a sand bag berm, the following criteria should be observed:

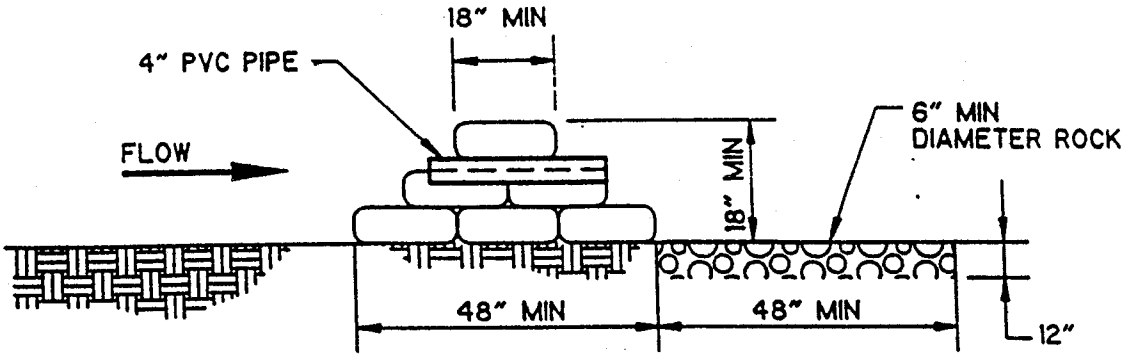
- Drainage Area - Up to five (5) acres.
- Height of Berm - 18 inches minimum height, measured from the top of the existing ground at the upslope toe to the top of the barrier.
- Width of Berm - 48 inches minimum width measured at the bottom of the barrier; 18 inches at the top.
- Sand bag Size - Length 24 to 30 inches, width 16 to 18 inches and thickness six (6) to eight (8) inches. Weight 90 to 125 pounds.
- Sand bag Material - Polypropylene, polyethylene or polyamide woven fabric, minimum unit weight four (4) ounces per square yard, mullen burst strength exceeding 300 psi and ultraviolet stability exceeding 70 percent. Use of burlap is discouraged since it rots and deteriorates easily.
- Grade of Sand - Coarse sand, gravel.
- Runoff water should be allowed to flow over the tops of the sand bags or through four (4) inch polyvinyl chloride pipes embedded below the top layer of bags.
- Area behind the sand bag barrier should be established according to sizing criteria for sediment trap BMP (ESC55).

REFERENCES

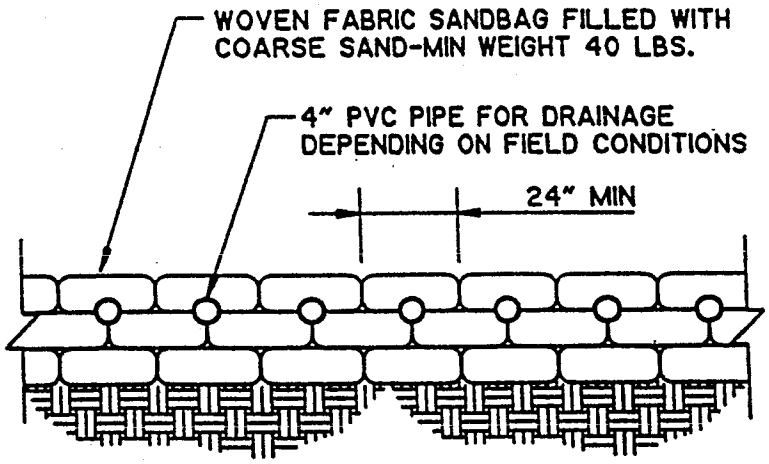
Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC52



CROSS-SECTION



FRONT VIEW

SAND BAG BERM

ESC52

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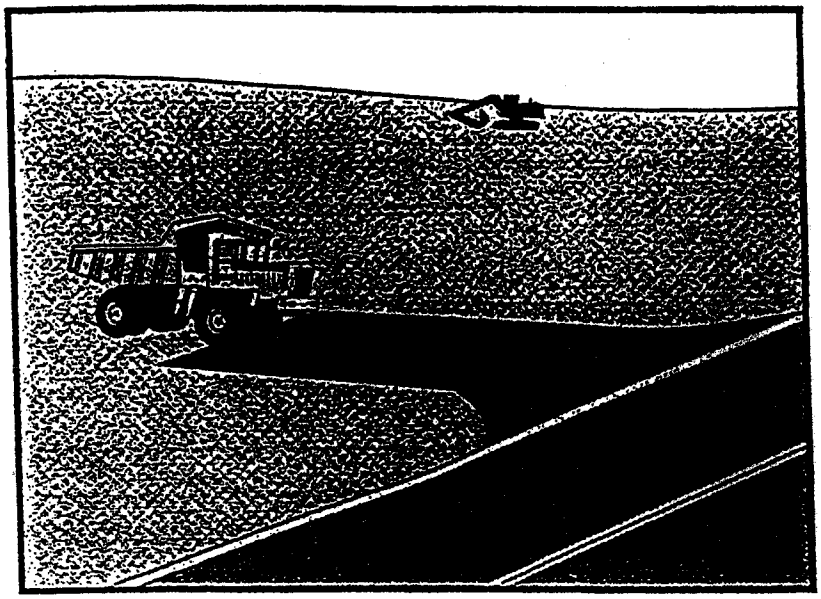
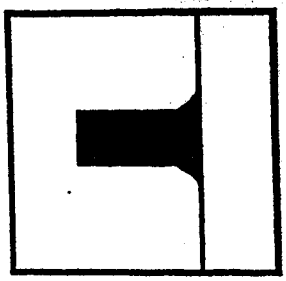
Stabilized Construction Entrance





BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ● Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water

Definition and Purpose

Procedures and practices to reduce the discharge of pollutants to the storm drain system or to watercourses as a result of vehicular ingress and egress to the construction site by designating and then stabilizing entrances and exits to prevent tracking of mud and dirt onto public roads.

Appropriate Applications

- On construction sites where dirt or mud tracking onto public roads by construction vehicles may occur.
- Includes combination ingress/egress paints and single purpose ingress and egress points.

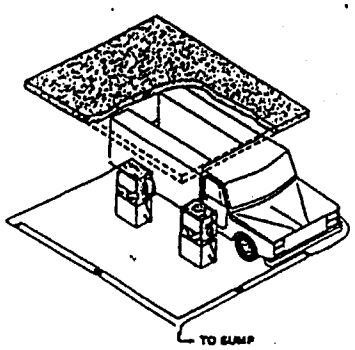
Limitations

- Site conditions will dictate design and need.

Standards and Specifications

- Design stabilized entrance to support heaviest vehicles and equipment that will use it.
- Properly grade entrance to prevent runoff from leaving construction site. Route runoff from stabilized entrance through a sediment trapping device before discharge.
- Select entrance stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions.

ACTIVITY: VEHICLE AND EQUIPMENT FUELING



Applications

- *Manufacturing*
- *Material Handling*
- *Vehicle Maintenance*
- *Construction*
- *Commercial Activities*
- *Roadways*
- *Waste Containment*
- *Housekeeping Practices*

DESCRIPTION

Prevent fuel spills and leaks, and reduce their impacts to storm water.

APPROACH

- Design the fueling area to prevent the runon of storm water and the runoff of spills:
  - Cover fueling area if possible.
  - Use a perimeter drain or slope pavement inward with drainage to sump.
  - Pave fueling area with concrete rather than asphalt.
- Where covering is infeasible and the fuel island is surrounded by pavement, apply a suitable sealant that protects the asphalt from spilled fuels.
- If dead-end sump is not used to collect spills, install an oil/water separator.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Discourage "topping-off" of fuel tanks.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Use adsorbent materials on small spills and general cleaning rather than hosing down the area. Remove the adsorbent materials promptly.
- Carry out all Federal and State requirements regarding underground storage tanks, or install above ground tanks.
- Do not use mobile fueling of mobile industrial equipment around the facility; rather, transport the equipment to designated fueling areas.
- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Train employees in proper fueling and cleanup procedures.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.

REQUIREMENTS

- Costs (Capital, O&M)
  - The retrofitting of existing fueling areas to minimize storm water exposure or spill runoff can be expensive. Good design must occur during the initial installation. Extruded curb along the "upstream" side of the fueling area to prevent storm water runon is of modest cost.
- Maintenance
  - Clean oil/water separators at the appropriate intervals.
  - Keep ample supplies of spill cleanup materials on-site.
  - Inspect fueling areas and storage tanks on a regular schedule.

LIMITATIONS

- Oil/water separators are only as effective as their maintenance program.

Targeted Constituents

- ○ *Sediment*
- ○ *Nutrients*
- ● *Heavy Metals*
- ● *Toxic Materials*
- ○ *Floatable Materials*
- ○ *Oxygen Demanding Substances*
- ● *Oil & Grease*
- ○ *Bacteria & Viruses*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ◒ *Training*

● *High* ○ *Low*

SC2

Best Management Practices

Additional Information — Vehicle and Equipment Fueling

Spills from fueling or from the transfer of fuels to the storage tank can be a significant source of pollution. Fuels carry contaminants of particular concern to humans and wildlife, such as heavy metals, toxic materials, and oil and grease, which are not easily removed by storm water treatment devices. Consequently, control at the source is particularly important. Adequate control can be achieved with careful design of the initial installation, retrofitting of existing installations, and proper spill control and cleanup procedures, as described below.

Design

With new installations, design the fueling area to prevent the runon of storm water and the runoff of spills. This can be achieved by contouring the site in the appropriate fashion. Covering the site is the best approach but may not be feasible if very large mobile equipment is being fueled. Storm water runon can be diverted around the fueling area by an extruded curb or with a "speed bump", if vehicle access is needed from this direction. Spills can be contained within the fueling area either by using a perimeter drain or by sloping the pavement inward with drainage to a sump. In both cases the drain can be connected to the storm drain with a valve that is only closed during fueling operations and left open at all other times. Pave the fueling area with Portland cement concrete rather than asphalt, since the latter will gradually disintegrate and be washed from the site.

Spill Control

The following spill control measures will reduce spilling or reduce the loss of spilled fuels from the site:

- Install vapor recovery nozzles.
- Do not "top off" tanks.
- Place secondary containment around the fuel truck when it is transferring fuel to the storage tank. The truck operator should remain with the truck while the transfer is in progress.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use dry methods to clean the fueling area whenever possible. If you periodically clean by pressure washing, place a temporary plug in the downstream drain and pump out the accumulated water. Properly dispose the water.
- Train employees on proper fueling and cleanup procedures.

Designated Area

If your facility has large numbers of mobile equipment working throughout the site and you currently fuel them with a mobile fuel truck, consider establishing a designated area for fueling. With the exception of tracked equipment such as bulldozers and perhaps small forklifts, most vehicles should be able to travel to a designated area with little lost time. Place temporary "caps" over nearby catch basins or manhole covers so that if a spill occurs it is prevented from entering the storm drain.

Examples of Effective Programs

- The Spill Prevention Control and Countermeasure (SPCC) Plan, which is required by law for some facilities, is an effective program to reduce the number of accidental spills.
- The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are also applicable to industrial facilities.

REFERENCES

Best Management Practices for Automotive-Related Industries, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

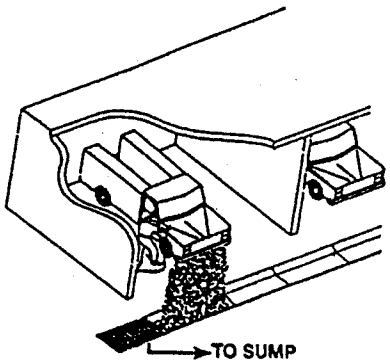
Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, USEPA, 1992.

Water Quality Best Management Practices Manual, City of Seattle, 1989.

SC2

ACTIVITY: VEHICLE AND EQUIPMENT WASHING & STEAM CLEANING



Applications

- *Manufacturing*
- *Material Handling*
- *Vehicle Maintenance*
- *Construction*
- *Commercial Activities*
- *Roadways*
- *Waste Containment*
- *Housekeeping Practices*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment washing and steam cleaning.

APPROACH

- Consider off-site commercial washing and steam cleaning businesses.
- Use designated wash areas, preferably covered to prevent contact with storm water and bermed to contain wash water.
- Discharge wash water to sanitary sewer, after contacting local sewer authority to find out if pretreatment is required.
- Educate employees on pollution prevention measures.
- Consider filtering and recycling wash water.
- Do not permit steam cleaning wash water to enter the storm drain.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.

REQUIREMENTS

- Capital costs vary depending on measures implemented.
  - Low cost ($500-1,000) for berm construction.
  - Medium cost ($5,000-20,000) for plumbing modifications (including re-routing discharge to sanitary sewer and installing simple sump).
  - High cost ($30,000-150,000) for on-site treatment and recycling.
- O&M costs increase with increasing capital investment.
- Maintenance
  - Berm repair and patching.
  - Inspection and maintenance of sumps, oil/water separators, and on-site treatment/ recycling units.

LIMITATIONS

- Some municipalities may require pretreatment and monitoring of wash water discharges to the sanitary sewer.
- Steam cleaning can generate significant pollutant concentrations requiring permitting, monitoring, pretreatment, and inspections. The measures outlined in this fact sheet are insufficient to address all the environmental impacts and compliance issues related to steam cleaning.

Targeted Constituents

- ● *Sediment*
- ● *Nutrients*
- ● *Heavy Metals*
- ● *Toxic Materials*
- ○ *Floatable Materials*
- ● *Oxygen Demanding Substances*
- ● *Oil & Grease*
- ○ *Bacteria & Viruses*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ○ *O&M Costs*
- ○ *Maintenance*
- ◒ *Training*

● *High* ○ *Low*

SC3

Best Management Practices

Additional Information — Vehicle and Equipment Washing and Steam Cleaning

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute storm water. If your facility washes or steam cleans a large number of vehicles or pieces of equipment, consider contracting out this work to a commercial business. These businesses are better equipped to handle and dispose of the wash waters properly. Contracting out this work can also be economical by eliminating the need for a separate washing/cleaning operation at your facility.

If washing/cleaning must occur on-site, consider washing vehicles inside the building to control the targeted constituents by directing them to the sanitary sewer where they can be pretreated or sent directly to the sanitary treatment facility. Washing operations outside should be conducted in a designated wash area having the following characteristics:

- Paved with Portland cement concrete,
- Covered or bermed to prevent contact with storm water,
- Sloped for wash water collection,
- Discharges wash water to the sanitary or process waste sewer, or to a dead-end sump. Discharge pipe should have a positive control valve that allows switching between the storm drain and sanitary or process sewer,
- Clearly designated, and
- Equipped with an oil/water separator (see Chapter 5, TC7, Oil/Water Separators and Water Quality Inlets).

Examples of Effective Programs

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are applicable to industrial vehicle service facilities.

The U.S. Postal Service in West Sacramento has a new vehicle wash system that collects, filters, and recycles the wash water.

REFERENCES

Best Management Practices for Automotive-Related Industries, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

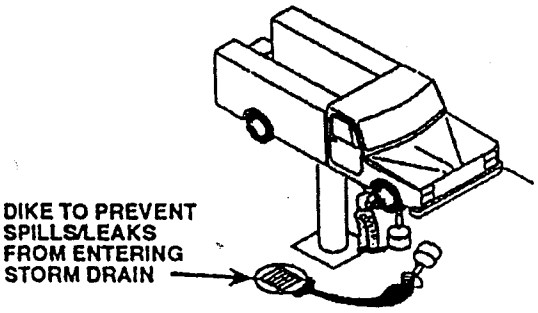
Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 8320R-92-006, USEPA, 1992.

Water Quality Best Management Practices Manual, City of Seattle, 1989.

SC3

Best Management Practices

ACTIVITY: VEHICLE AND EQUIPMENT MAINTENANCE AND REPAIR



Applications

- *Manufacturing*
- *Material Handling*
- *Vehicle Maintenance*
- *Construction*
- *Commercial Activities*
- *Roadways*
- *Waste Containment*
- *Housekeeping Practices*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment maintenance and repair by running a dry shop.

APPROACH

- Keep equipment clean, don't allow excessive build-up of oil and grease.
- Keep drip pans or containers under the areas that might drip.
- Do not change motor oil or perform equipment maintenance in non-appropriate areas. Use a vehicle maintenance area designed to prevent storm water pollution.
- Inspect equipment for leaks on a regular basis.
- Segregate wastes.
- Make sure oil filters are completely drained and crushed before recycling or disposal..
- Make sure incoming vehicles are checked for leaking oil and fluids.
- Clean yard storm drain inlets(s) regularly and especially after large storms.
- Do not pour materials down drains or hose down work areas; use dry sweeping.
- Store idle equipment under cover.
- Drain all fluids from wrecked vehicles.
- Recycle greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids.
- Switch to non-toxic chemicals for maintenance when possible.
- Clean small spills with rags, general clean-up with damp mops and larger spills with absorbent material.
- Paint signs on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- Train employees.
- Minimize use of solvents.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.

REQUIREMENTS

- Costs (Capital, O&M) - Should be low, but will vary depending on the size of the facility.
- Maintenance - Should be low if procedures for the approach are followed.

LIMITATIONS

- Space and time limitations may preclude all work being conducted indoors.
- It may not be possible to contain and clean up spills from vehicles/equipment brought on-site after working hours.
- Drain pans (usually 1 ft. x 1 ft.) are generally too small to contain antifreeze, which may gush from some vehicles, so drip pans (3 ft. x 3 ft.) may have to be purchased or fabricated.
- Dry floor cleaning methods may not be sufficient for some spills. Use three-step method instead.
- Identification of engine leaks may require some use of solvents.

Targeted Constituents

- ○ *Sediment*
- ○ *Nutrients*
- ● *Heavy Metals*
- ● *Toxic Materials*
- ○ *Floatable Materials*
- ○ *Oxygen Demanding Substances*
- ● *Oil & Grease*
- ○ *Bacteria & Viruses*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ◒ *Training*

● *High* ○ *Low*

SC4

Additional Information — Vehicle and Equipment Maintenance and Repair

Vehicle or equipment maintenance is a potentially significant source of storm water pollution. Activities that can contaminate storm water include engine repair and service (parts cleaning, spilled fuel, oil, etc.), replacement of fluids, and outdoor equipment storage and parking (dripping engines). For further information on vehicle or equipment servicing, see SC2, Vehicle and Equipment Fueling, and SC3, Vehicle and Equipment Washing and Steam Cleaning.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane or methylene chloride. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Cleaning without using liquid cleaners (e.g. wire brush) whenever possible reduces waste. Prevent spills and drips of solvents and cleansers to the shop floor. Do all liquid cleaning at a centralized station so the solvents and residues stay in one area. Locate drip pans, drain boards, and drying racks to direct drips back into a solvent sink or fluid holding tank for re-use.

Safer Alternatives

If possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example:

- Use non-caustic detergents instead of caustic cleaning agents for parts cleaning (ask your supplier about alternative cleaning agents).
- Use detergent-based or water-based cleaning systems in place of organic solvent degreasers. Wash water may require treatment before it can be discharged to the sewer. Contact your local sewer authority for more information.
- Replace chlorinated organic solvents (1,1,1-trichloroethane, methylene chloride, etc.) with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated.
- Choose cleaning agents that can be recycled.
- Contact your supplier or refer to trade journals for more waste minimization ideas.

Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents.

Recycling

Separating wastes allows for easier recycling and may reduce treatment costs. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents (like 1,1,1-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits).

Many products made of recycled (i.e., refined or purified) materials are available. Engine oil, transmission fluid, antifreeze, and hydraulic fluid are available in recycled form. Buying recycled products supports the market for recycled materials.

Spill Leak Clean Up

Clean leaks, drips, and other spills with as little water as possible. Use rags for small spills, a damp mop for general cleanup, and dry absorbent material for larger spills. Use the following three-step method for cleaning floors:

1. Clean spills with rags or other absorbent materials.
2. Sweep floor using dry absorbent material.
3. Mop floor. Mop water may be discharged to the sanitary sewer via a toilet or sink.

SC4

Additional Information — Vehicle and Equipment Maintenance and Repair

Good Housekeeping

Also consider the following measures:

- Avoid hosing down your work areas. If work areas are washed, direct wash water to sanitary sewer.
- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- Keep a drip pan under the vehicle while you unclip hoses, unscrew filters, or remove other parts. Use a drip pan under any vehicle that might leak while you work on it to keep splatters or drips off the shop floor.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.

Do not pour liquid waste to floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections. Used or leftover cleaning solutions, solvents, and automotive fluids and oil are toxic and should not be put in the sanitary sewer. Post signs at sinks to remind employees, and paint stencils at outdoor drains to tell customer and others not to pour wastes down drains.

Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Most municipalities prohibit or discourage disposal of these items in solid waste facilities. Place the oil filter in a funnel over the waste oil recycling or disposal collection tank to drain excess oil before disposal. Oil filters can be crushed and recycled. Ask your oil supplier or recycler about recycling oil filters.

Put pans under leaks to collect fluids for proper recycling or disposal. Keeping leaks off the ground reduces the potential for storm water contamination and reduces cleanup time and costs. If the vehicle or equipment is to be stored outdoors, oil and other fluids should be drained first.

Designate a special area to drain and replace motor oil, coolant, and other fluids, where there are no connections to the storm drain or the sanitary sewer and drips and spills can be easily cleaned up.

Be especially careful with wrecked vehicles, whether you keep them indoors or out, as well as vehicles kept on-site for scrap or salvage. Wrecked or damaged vehicles often drip oil and other fluids for several days.

- As the vehicles arrive, place drip pans under them immediately, even if you believe that the fluids have leaked out before the car reaches your shop.
- Build a shed or temporary roof over areas where you park cars awaiting repair or salvage, especially if you handle wrecked vehicles. Build a roof over vehicles you keep for parts.
- Drain all fluids, including air conditioner coolant, from wrecked vehicles and "part" cars. Also drain engines, transmission, and other used parts.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

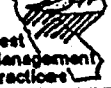
Examples of Effective Programs

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are also applicable to industrial vehicle service facilities.

Pick N Pull Auto Dismantlers in Rancho Cordova drains all fluids from automobiles before they enter the yard.

Ecology Auto Wrecking in Rialto is surrounded by a steel plate/concrete fence and has a completely paved lot that is graded to a central low point. Collected storm water is channeled through as underground drainage system of clarifiers

SC4



and then stored in a 60,000 gallon UST before being processed through a filter system. In addition, the work area is covered, ventilated and has an additional sump. Vehicle fluids are drained in this area and segregated for recycling.

All Auto Parts, Fontana, has a complete water recycling system in a 10,000 square foot concrete slab surrounded by a curb that contains all the runoff and sends it to the recycling system. All receiving, dismantling, and shipping occurs on the slab.

REFERENCES

Best Management Practices for Automotive-Related Industries, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Best Management Practices for Controlling Oil and Grease in Urban Storm Water Runoff, G. S. Silverman, et. al, 1986 Environmental Professional, Vol. 8, pp 351-362.

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Fact Sheet - Waste Reduction for Automotive Repair Shops; DTSC, 1989.

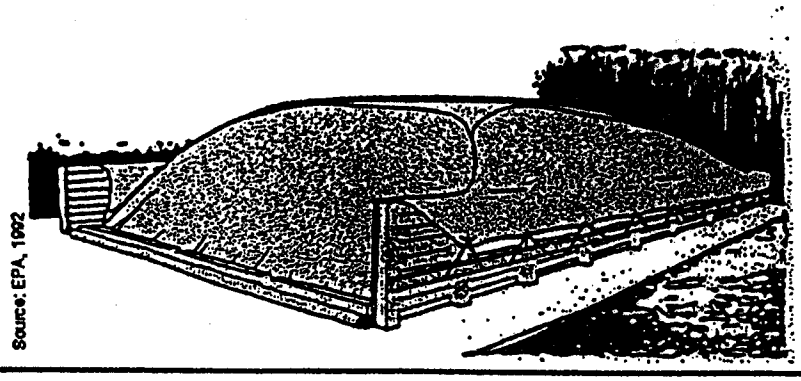
Hazardous Waste Reduction Assessment Handbook - Automotive Repair Shops; DTSC, 1988.

Hazardous Waste Reduction Checklist - Automotive Repair Shops; DTSC, 1988.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, USEPA, 1992.

SC4

ACTIVITY: OUTDOOR STORAGE OF RAW MATERIALS, PRODUCTS, AND BY- PRODUCTS



Applications

- *Manufacturing*
- ***Material Handling***
- *Vehicle Maintenance*
- ***Construction***
- ***Commercial Activities***
- *Roadways*
- *Waste Containment*
- ***Housekeeping Practices***

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from outdoor material and product storage areas by enclosing or covering materials, installing secondary containment, and preventing storm water runon.

APPROACH

- Protect materials from rainfall, runon, runoff and wind dispersal:
  - Store material indoors.
  - Cover the storage area with a roof.
  - Cover the material with a temporary covering made of polyethylene, polypropylene, or hypalon.
  - Minimize storm water runon by enclosing the area or building a berm around the area.
  - Use "doghouse" for storage of liquid containers.
- Parking lots or other surfaces near bulk materials storage areas should be swept periodically to remove debris blown or washed from storage area.
- Install pellet traps at storm water discharge points where plastic pellets are loaded and unloaded.
- Keep liquids in a designated area on a paved impervious surface within a secondary containment.
- Keep outdoor storage containers in good condition.
- Use berms and curbing.
- Use catch basin filtration inserts (Chapter 5, TC6, Media Filtration)

REQUIREMENTS

- Costs (Capital, O&M)
  - Costs should be low except where large areas may have to be covered.
- Maintenance
  - Berm and curbing repair and patching.

LIMITATIONS

- Space limitations may preclude storing some materials indoors.
- Some municipalities require that secondary containment areas (regardless of size) be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.
- Storage sheds often must meet building and fire code requirements.

Targeted Constituents

- ● *Sediment*
- ○ *Nutrients*
- ● *Heavy Metals*
- ● *Toxic Materials*
- ● *Floatable Materials*
- ○ *Oxygen Demanding Substances*
- ● *Oil & Grease*
- ○ *Bacteria & Viruses*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ○ *O&M Costs*
- ○ *Maintenance*
- ◒ *Training*

● *High* ○ *Low*

SC8

Best Management Practices

Additional Information — Outdoor Storage of Raw Materials, Products, and By-Products

Raw materials, by-products, finished products, containers, and material storage areas exposed to rain and/or runoff can pollute storm water. Storm water can become contaminated by a wide range of contaminants when materials wash off or dissolve into water or are added to runoff by spills and leaks.

Paved areas should be sloped in a manner that minimize the pooling of water on the site, particularly with materials that may leach pollutants into storm water and/or groundwater, such as compost, logs, and wood chips. A minimum slope of 1.5 percent is recommended.

Curbing should be placed along the perimeter of the area to prevent the runon of uncontaminated storm water from adjacent areas as well as runoff of storm water from the stockpile areas. The storm drainage system should be designed to minimize the use of catch basins in the interior of the area as they tend to rapidly fill with manufacturing material. In these cases, consider the use of the catch basin insert filter described in Chapter 5, TC6 (Media Filtration). The area should be sloped to drain storm water to the perimeter where it can be collected or to internal drainage alleyways where material is not stockpiled. If the raw material, by-product, or product is a liquid, more information for outside storage of liquids can be found under SC6, Outdoor Container Storage of Liquids.

Examples

The "doghouse" design has been used to store small liquid containers. The roof and flooring design prevent contact with direct rain or runoff. The doghouse has two solid structural walls and two canvas covered walls. The flooring is wire mesh about secondary containment. The unit has been used successively at Lockheed Missile and Space Company in Sunnyvale.

REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, EPA, 1992.

Water Quality Best Management Practices Manual, City of Seattle, 1989.

SC8

ACTIVITY: WASTE HANDLING AND DISPOSAL

Applications

- *Manufacturing*
- *Material Handling*
- *Vehicle Maintenance*
- *Construction*
- *Commercial Activities*
- *Roadways*
- *Waste Containment*
- *Housekeeping Practices*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from waste handling and disposal by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction, re-use, and recycling; and preventing runon and runoff from waste management areas.

APPROACH

- Maintain usage inventory to limit waste generation.
- Raw material substitution or elimination.
- Process or equipment modification.
- Production planning and sequencing.
- SARA Title III, Section 313 requires reporting for over 300 listed chemicals and chemical compounds. This requirement should be used to track these chemicals although this is not as accurate a means of tracking as other approaches.
- Track waste generated.
  - Characterize waste stream.
  - Evaluate the process generating the waste.
  - Prioritize waste streams using: manifests, biennial reports, permits, environmental audits, SARA Title III reports, emission reports, NPDES monitoring reports.
  - Inventory reports.
  - Data on chemical spills.
  - Emissions.
  - Shelf life expiration.
- Use design data and review: process flow diagram, materials and applications diagram, piping and instructions, equipment list, plot plan.
- Use raw material and production data and review: composition sheets, materials safety data sheets (MSDS), batch sheets, product or raw material inventory records, production schedule, operator data log.
- Use economic data and review:
  - Waste treatment and disposal cost.
  - Product utility and economic cost.
  - Operation and maintenance labor cost.
- Recycle materials whenever possible.
- Maintain list of and the amounts of materials disposed.
- Waste segregation and separation.
- Check industrial waste management areas for spills and leaks.
- Cover, enclose, or berm industrial wastewater management areas whenever possible to prevent contact with runon or runoff.
- Equip waste transport vehicles with anti-spill equipment.

Targeted Constituents

- ○ *Sediment*
- ○ *Nutrients*
- ● *Heavy Metals*
- ● *Toxic Materials*
- ○ *Floatable Materials*
- ○ *Oxygen Demanding Substances*
- ● *Oil & Grease*
- ○ *Bacteria & Viruses*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ◒ *O&M Costs*
- ○ *Maintenance*
- ◒ *Training*

● *High* ○ *Low*

SC9

Best Management Practices

- Minimize spills and fugitive losses such as dust or mist from loading systems.
- Ensure that sediments or wastes are prevented from being tracked off-site.
- Training and supervision.
- Stencil storm drains on the facility's property with prohibitive message regarding waste disposal.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.
- Consider ordering industry-specific or waste stream-specific guidance from PPIC (see Appendix G).

REQUIREMENTS

- Costs (Capital, O&M)
  - Capital and O&M costs for these programs will vary substantially depending on the size of the facility and the types of waste handled. Costs should be low if there is an inventory program in place.
- Maintenance
  - None except for maintaining equipment for material tracking program.

LIMITATIONS

- Hazardous waste that cannot be re-used or recycled must be disposed of by a licensed hazardous waste hauler.

SC9

Additional Information — Waste Handling and Disposal

Industrial waste management activities occur in areas that can contaminate storm water and include landfills, waste piles, wastewater and solid waste treatment and disposal, and land application. Typical operations which affect storm water pollution may include waste pumping, treatment chemicals storage, mixing, aeration, clarification, and solids dewatering.

Waste Reduction

Waste spilled, leaked, or lost from waste management areas or outside manufacturing activities may build up in soils or in other surfaces and be carried away by storm water runoff. There is also a potential for liquid waste from lagoons or surface impoundments to overflow to surface waters or soak the soil where pollutants may be picked up by storm water runoff.

Waste reduction for manufacturing activities is the best way to reduce the potential of storm water contamination from waste management areas. Reduction in the amount of industrial waste generated can be accomplished using many different types of source controls such as:

- Production planning and sequencing.
- Process or equipment modification.
- Raw material substitution or elimination.
- Loss prevention and housekeeping.
- Waste segregation and separation.
- Close loop recycling.

An approach to reduce storm water pollution from waste handling and disposal is to assess process activities at the facility and reduce waste generation. The assessment is designed to find situations where waste can be eliminated or reduced and emissions and environmental damage can be minimized. The assessment involves collecting process specific information, setting pollution prevention targets, and developing, screening and selecting waste reduction options for further study. Starting a waste reduction program is economically beneficial because of reduced raw material purchases and lower waste disposal fees. In addition, material tracking systems to increase awareness about material usage can reduce spills and minimize contamination, thus reducing the amount of waste produced.

Spill/Leak Control

Waste can be prevented from contaminating storm water by checking waste management areas for leaking containers or spills. Corroded or damaged containers can begin to leak at any time. Transfer waste from these damaged containers into safe containers. Dumpsters should be covered to prevent rain from washing waste out of holes or cracks in the bottom of the dumpster. Leaking equipment including valves, lines, seals, or pumps should be repaired promptly.

Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The spill prevention equipment includes:

- Vehicles equipped with baffles for liquid waste.
- Trucks with sealed gates and spill guards for solid waste.

Loading or unloading wastes can contaminate storm water when the wastes are lost from the transfer. Loading systems can also be used to minimize spills and fugitive emission losses such as dust or mist. Vacuum transfer systems can minimize waste loss.

Runon/Runoff Prevention

Storm water runon should be prevented from entering the waste management area. Storm water pollution from runon can be prevented by enclosing the area or building a berm around the area. Other alternatives for reducing storm water pollution include:

- Preventing the waste materials from directly contacting rain.

SC9

Additional Information — Waste Handling and Disposal

- Moving the activity indoor after ensuring that all safety concerns such as fire hazard and ventilation are addressed.
- Covering the area with a permanent roof.
- Covering waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropylene or hypalon.

To avoid tracking materials off-site, the waste management area should be kept clean at all times by sweeping and cleaning up spills immediately. Vehicles should never drive through spills. If necessary, wash vehicles in designated areas before they leave the site, and control the wash water.

Minimizing the runoff of polluted storm water from land application of industrial waste on-site can be accomplished by:

- Choosing a site where:
  - slopes are under 6 percent
  - the soil is permeable
  - there is a low water table
  - it is located away from wetlands or marshes
  - there is a closed drainage system
- Avoiding applying waste to the site:
  - when it is raining
  - when the ground is frozen
  - when the ground is saturated with water
- Growing vegetation on land disposal areas to stabilize soils and reduce the volume of surface water runoff from the site.
- Maintaining adequate barriers between the land application site and the receiving waters. Planted strips are particularly good.
- Using erosion control techniques
  - mulching and matting,
  - filter fences,
  - straw bales,
  - diversion terracing,
  - sediment basins.
- Performing routine maintenance to ensure the erosion control or site stabilization measures are working.

Examples of Effective Programs

The port of Long Beach has a state-of-the-art database for identifying potential pollutant sources, documenting facility management practices, and tracking pollutants.

REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Publications Than Can Work For You!; California Department of Toxic Substances Control, Sacramento, CA, 1991 (A list and order form for waste minimization publications from the State).

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, USEPA, 1992.

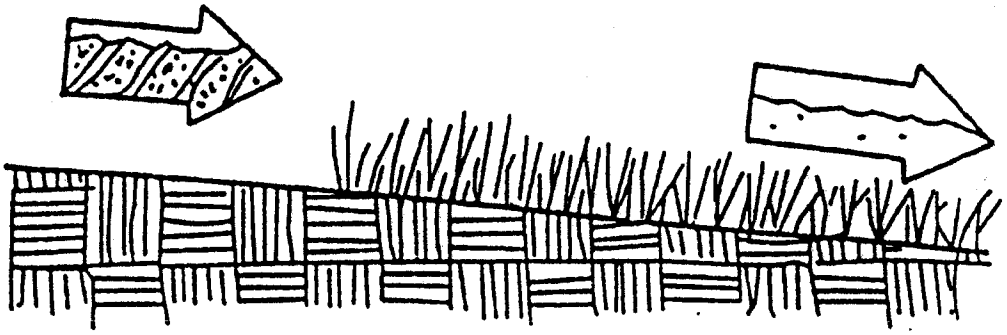
Distribute List, Pollution Prevention Information Clearinghouse, USEPA 1992.

SC9

APPENDIX B

POST CONSTRUCTION BMPS

BMP: SEEDING AND PLANTING



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- **Stabilize Disturbed Areas**
- **Protect Slopes/Channels**
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

Seeding of grasses and plantings of trees, shrubs, vines and ground covers provide long-term stabilization of soil. In some areas, with suitable climates, grasses can be planted for temporary stabilization.

SUITABLE APPLICATIONS

- Appropriate for site stabilization both during construction and post-construction.
- Any graded/cleared areas where construction activities have ceased.
- Open space cut and fill areas.
- Steep slopes.
- Spoil piles.
- Vegetated swales.
- Landscape corridors.
- Stream banks.

INSTALLATION/APPLICATION CRITERIA

Type of vegetation, site and seedbed preparation, planting time, fertilization and water requirements should be considered for each application.

Grasses:

- Ground preparation: fertilize and mechanically stabilize the soil.
- Tolerant of short-term temperature extremes and waterlogged soil conditions.
- Appropriate soil conditions: shallow soil base, good drainage, slope 2:1 or flatter.
- Develop well and quickly from seeds.
- Mowing, irrigating, and fertilizing are vital for promoting vigorous grass growth.

Trees and Shrubs:

- Selection Criteria: vigor, species, size, shape & wildlife food source.
- Soil conditions: select species appropriate for soil,drainage & acidity.
- Other Factors: wind/exposure, temperature extremes, and irrigation needs.

Vines and Ground Covers:

- Ground preparation: lime and fertilizer preparation.
- Use proper seeding rates.
- Appropriate soil conditions: drainage, acidity, slopes.
- Generally avoid species requiring irrigation.

Targeted Pollutants

- ● Sediment
- ◒ Nutrients
- ◒ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ◒ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

ESC10

Best Management Practices

BMP: SEEDING AND PLANTING (Continue)

REQUIREMENTS

- Maintenance
  - Shrubs and trees must be adequately watered and fertilized and if needed pruned.
  - Grasses may need to be watered and mowed.
- Cost: Average annual cost for installation and maintenance (2-year useful life, source: EPA, 1992)
  - Seeding: $300 per acre, appropriate for flat slopes and stable soils.
  - Seeding with Mulching: $1,100 per acre, appropriate for moderate to steep slopes and/or erosive soils.
  - Trees, shrubs, vines, and ground cover: Cost, applicability based on species used and terrain features.

LIMITATIONS

- Permanent and temporary vegetation may not be appropriate in dry periods without irrigation.
- Fertilizer requirements may have potential to create storm water pollution if improperly applied.

ESC10

Additional Information — Seeding and Planting

Permanent seeding of grasses, sodding, and planting of trees, shrubs, vines and ground covers can provide long-term stabilization of soil. Permanent seeding and planting contributes to long-term site aesthetics and helps reduce erosion by reducing the velocity of runoff, allowing infiltration to occur, filtering sediments, and by holding soil particles in place.

Seeding and planting should be applied as soon as final grading is done to all graded and cleared areas of the construction site where plant cover is ultimately desired. For example, vegetation may be established along landscaped corridors and buffer zones where they may act as filter strips (see TC6 in Chapter 5 of the Municipal Handbook). Additionally, vegetated swales, steep and/or rocky slopes and stream banks can also serve as appropriate areas for seeding and plantings.

Installation/Application Criteria

Application of appropriate vegetation must consider: the seedbed or plantbed, proper seasonal planting times, water requirements fertilizer requirements and availability of the selected vegetation within the project's region. Permanent plantings during the construction stage of projects require careful coordination between the local agency inspectors, project managers, construction managers, and landscape contractor. Protocols for coordination and implementation procedures regarding site access, construction staging, and short- and long-term planting areas should be developed prior to the construction bid process. Where possible, these protocols should be established by and remain the responsibility of the site owner.

Because of the many available types of plants and ground covers and because site conditions and land use vary so widely within California, a set of general guidelines is included for installation/application of grasses, trees and shrubs, vines and ground covers. However, your local municipality, Soil Conservation Service, agricultural extention, or other resources should be consulted on appropriate species, planting requirements, and maintenance needs for your climate and soils.

Grasses

Grasses, depending on the type, provide short-term soil stabilization during construction or can serve as long- term/ permanent soil stabilization for disturbed areas. In general, grasses provide low maintenance to areas that have been cleared, graded and mechanically stabilized.

Selection:

The selection of the grass type is determined by the climate, irrigation, mowing frequency, maintenance effort and soil-bed conditions. Although grasses provide quick germination and rapid growth, they also have a shallow root system and are not as effective in stabilizing deep soils, where trees, shrubs and deep rooted ground covers may be more appropriate. Several grasses are adaptable to the various California climates. The figure at the end of these fact sheets shows appropriate grasses for regions within California. Blue grass is well adapted throughout California except for in the valley regions. The blue grass is found on dry, sandy soils that have good drainage. Bermuda grass, on the other hand is well adapted in the valley region where soils are dry, coarse and heavier. Specific seed mix and/or varieties for each site should be provided by an approved/qualified plant materials specialist.

ESC10

Additional Information — Seeding and Planting

Planting:
The following steps should be followed to ensure established growth:

1. Select the proper grass for the site.
2. Prepare the seedbed; soil should be fertilized and contain good topsoil or soil at least a 2:1 or flatter slope.
3. Broadcast the seedings in the late fall or early spring. In the late fall, seedings should be planted by mid- September to have established grass by the October rainy season.
4. Initial irrigation will be required often for most grasses, with follow-up irrigation and fertilization as needed. Mulching may be required in dry climates or during drought years.

Trees & Shrubs

Selection:
Trees and shrubs, when properly selected, are low maintenance plantings that stabilize adjacent soils, moderate the adjacent temperatures, filter air pollutants, and serve as a barrier to wind. Some desirable characteristics to consider in selecting trees and shrubs include: vigor, species, age, size and shape, and use as a wildlife food source and habitat.

Trees and shrubs to be saved should be clearly marked so that no construction activity will take place within the dripline of the plant. The sites for new plantings should be evaluated. Consider the prior use of the land: adverse soil conditions such as poor drainage or acidity; exposure to wind; temperature extremes; location of utilities, paved areas, and security lighting and traffic problems.

Transplanting:
Time of Year - Late fall through winter (November to February) is the preferred time for transplanting in most of California.

Preparation - Proper digging of a tree/shrub includes the conservation of as much of the root system as possible. Soil adhering to the roots should be damp when the tree is dug, and kept moist until re-planting. The soil ball should be 12 inches in diameter for each inch of diameter of the trunk.

Site preparation - Refer to landscape plans and specifications for site and soil preparation, and for ability to coordinate construction strategy with permanent vegetation.

Supporting the trunk - Many newly planted trees/shrubs need artificial support to prevent excessive swaying.

Watering - Soil around the tree should be thoroughly watered after the tree is set in place. When the soil becomes dry, the tree should be watered deeply, but not often. Mulching around the base of the tree is helpful in preventing roots from drying out.

Vines & Ground Covers

Selection:
Vines, ground covers, and low growing plants, that can quickly spread, come in many types, colors, and growth habits. Some are suitable only as part of a small maintained landscape area, while some can stabilize large areas with little maintenance. Flowers, which provide little long-term erosion control may be planted to add color and varietal appearances.

ESC10

Additional Information — Seeding and Planting

Caution should be exercised in the non-native vegetation because of impacts to native vegetation on adjacent lands. For example, species that may be planted at the construction site can quickly spread and compete with originally undisturbed vegetation such as the California Poppy and California buckwheat, both of which complete poorly with introduced grasses (e.g., planting wild oats is illegal in California). In addition to stabilizing disturbed soil, vines and ground covers can perform the following functions:

1. Provide attractive cover that does not need mowing.
2. Help to define traffic areas and control pedestrian movement.

Site Preparation:
Ground covers are plants that naturally grow very close together, causing severe competition for space nutrients and water. Soil for ground covers should be well prepared. The entire area should be spaded, disced, or rototilled to a depth of six to eight inches. Two to three inches of organic material, such as good topsoil or peat, should be spread over the entire area.

Planting:
The following steps will help ensure good plant growth.

1. Make the plantings following the contours of the land.
2. Dig the holes 1/3 larger than the plant root ball.
3. Know what depth to place the plants.
4. Use good topsoil or soil mixture with a lot of organic matter.
5. Fill hole 1/3 to 1/2 full, shake plants to settle soil among roots, then water.
6. Leave saucer-shaped depression around the plant to hold water.
7. Water thoroughly and regularly.
8. Space plants according to the type of plant and the extent of covering desired.

Materials:
There are many different species of vines and ground covers from which to choose, but care must be taken in their selection. It is essential to select planting materials suited to both the intended use and specific site characteristics. The plants discussed in this handbook are those which are known to be adapted to California, and commonly available from commercial nurseries. Additional information can be obtained from local nurserymen, landscape architects, and extension agents. An approved low water use plant list may be obtained from the State Department of Water Resources or the Soils Conservation Service.

Requirements
Maintenance

General requirements include:

- Grass maintenance should be minimal to none. Irrigation and regular fertilizing may be required for some types of grasses. Mowing is only required in areas where aesthetics or fire hazards are a concern.
- Young trees should receive an inch of water each week for the first two years after planting. The tree should be watered deeply, but not more often than once per week.
- Transplanted trees should be fertilized on an annual basis.
- Proper pruning, watering, and application of fertilizer is necessary to maintain healthy and vigorous shrubs. A heavy layer of mulch applied around the shrubs reduces weeds and retains moisture.
- Trim old growth as needed to improve the appearance of ground covers. Most covers need once-a-year trimming to promote growth.

ESC10

Additional Information — Seeding and Planting

Limitations

- Construction activities are likely to injure or kill trees unless adequate protective measures are taken. Direct contact by equipment is the most obvious problem, but damage is also caused by root stress from filling, excavation, or compacting too close to trees.
- Temporary seeding can only be viable when adequate time is available for plants to grow and establish.
- Over fertilizing of plants may cause pollution of storm water runoff.
- Irrigation source and supply may be limiting.

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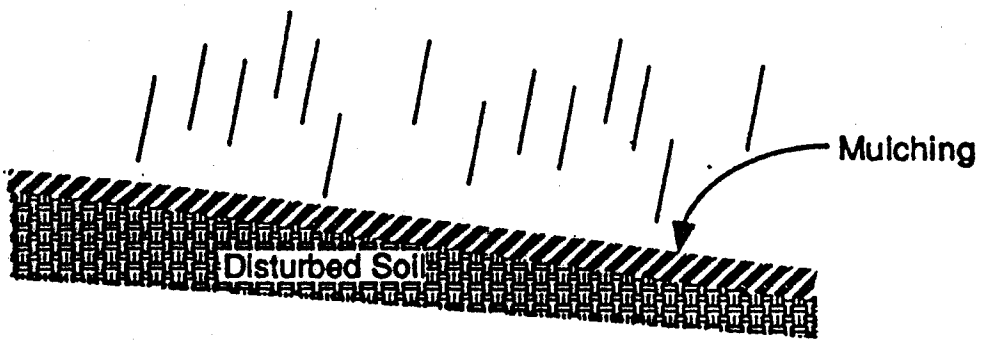
ESC10

BMP: MULCHING



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- **Stabilize Disturbed Areas**
- **Protect Slopes/Channels**
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

Mulching is used to temporarily and permanently stabilize cleared or freshly seeded areas. Types of mulches include organic materials, straw, wood chips, bark or other wood fibers, decomposed granite, and gravel.

SUITABLE APPLICATIONS

- Temporary stabilization of freshly seeded and planted areas.
- Temporary stabilization during periods unsuitable for growing vegetation.
- Temporary stabilization of areas that cannot be seeded or planted (e.g., insufficient rain, steep slope).
- Mulches such as gravel and decomposed soils may be used as post-construction BMPs, particularly in arid regions.

INSTALLATION/APPLICATION CRITERIA

Mulch prevents erosion by protecting the soil surface and fostering growth of new seedings that do not stabilize by themselves.

- May be used with netting to supplement soil stabilization.
- Apply to planting areas where slopes are 2:1 or greater.
- Binders may be required for steep areas, or if wind and runoff is a problem.
- Type of mulch, binders, and application rates should be recommended by manufacturer/contractor.

REQUIREMENTS

- Maintenance
  - Must be inspected weekly and after rain for damage or deterioration.
- Cost: Average annual cost for installation and maintenance (3-4 month useful life, source: EPA, 1992)
  - Straw Mulch: $7,500 per acre.
  - Wood Fiber Mulch: $3,500 per acre.
  - Jute Netting: $12,500 per acre.

LIMITATIONS

- Wood fiber mulches should be used only in areas with over 20 inches annual precipitation.
- Organic mulches are not permanent erosion control measures.
- Mulches tend to lower the soil surface temperature, and may delay germination of some seeds.
- Permanent mulches for arid regions should include gravel and decomposed soils.

Targeted Pollutants

- ● Sediment
- ◒ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training
- ● Suitability for Slopes >5%

● High ○ Low

ESC11

Best Management Practices

Additional Information — Mulching

Mulching protects the soil from rainfall impact; increases infiltration; conserves moisture around trees, shrubs and seedings; prevents compaction and cracking of soil; and aids plant growth for seedings and plantings by holding the seeds, fertilizers and topsoil in place until growth occurs. Mulches include organic materials, straw, wood chips, bark or other wood fibers, decomposed granite and gravel. A variety of nettings or mats of organic or non-organic materials and chemical soil stabilization are practices that may be used conjunctively with mulching.

Mulching may be applied to all graded and cleared areas of the construction site:

- Areas which have been permanently seeded to assist in retaining moisture, and to hold seedings;
- Areas which need temporary soil surface protection because seeding cannot occur due to the season;
- Areas between trees, shrubs and certain ground covers;
- Areas where climatic conditions require a soil moisture retention aid to avoid cracking of the soil and associated compaction, and require soil temperature modification.

Installation/Application Criteria

Only a set of general guidelines is included for application and installation of mulching on disturbed lands because of the various climates, soil conditions and land uses in California. Installation of mulch consists of furnishing all materials, preparing the soil surface and applying the mulch to all soil surface areas designated on the project plans or established by the site engineer.

Materials

Organic mulch materials, such as straw, wood chips, bark and wood fiber, have been found to be most effective where re-vegetation will be provided by reseeding. The choice of mulch should be based on the size of the area, site slopes, surface conditions such as hardness and moisture; weed growth and availability of mulch materials.

Wood Fiber Mulches: Wood fiber mulches consist of specially prepared wood fiber processed to contain no growth germination inhibiting factors. The mulch should be from virgin wood, and be manufactured and processed so the fibers will remain in uniform suspension in water under agitation to form a homogenous slurry. The fiber lengths should be as long as possible to increase the effectiveness for erosion control. Wood fiber mulching should not be used in areas of extremely hot summer and late fall seasons because of fire danger. When used as a tackifier with straw mulch, wood fiber mulches are good for steep slopes and severe climates. The California Office of the Soils Conservation Service recommends a non-toxic mulch green dye be used to provide a visual aid in metering applications.

Wood Chips and Bark Chips: Wood and bark chips are suitable for application in landscaped areas that will not be closely mowed. Wood chips do not require tacking, but do require nitrogen treatment (12 pounds/ton) to prevent nutrient deficiency. Bark chips do not require additional nitrogen fertilizer. When the wood source is near the project site, wood and bark chips can be very inexpensive. Caution must be used in areas of steep slopes, since both wood and bark chips tend to wash down slopes exceeding 6 percent.

Straw Mulch: Straw mulch is a good short-term protection most commonly used with seeding. The mulch should be from the current season's crop. A letter of certification from the supplier should be required to show that the straw was baled less than 12 months from the delivery date. Wheat or oat straw is recommended.

Emulsified Asphalt: Asphalt is used to adhere the mulch to the ground surface, preventing the mulch from blowing or washing off. The type and quantity of asphalt used should not result in a storm water pollution problem.

Binder: Binder should be free flowing, noncorrosive powder produced from natural plant gum such as those marketed under M-Binder, M145 Binder, or AZ-TAC. Synthetic, spray-on materials are not recommended since they tend to create an impervious surface, and may enter the stormwater sewer system via discharge runoff.

ESC11

Additional Information — Mulching

Preparations/Methods and Equipment

Straw Mulch: Should be applied in an even, uniform manner, either by hand or by mulch blowing equipment. Straw mulches must be anchored to prevent the mulch from being blown or washed off the site. Anchoring is achieved in two ways:

- Crimping: The mulch is anchored by running a heavy disc with flat, dull, serrated, closely-spaced blades over the mulched soil. Effective crimping embeds the mulch about 2 inches into the soil without completely covering it. The disc should be run once or twice across the soil. About 2 1/2 tons of straw mulch per acre should be applied if the mulch is anchored by crimping.
- Tacking: Achieved using a emulsified asphalt or binder either independently or followed by crimping. If tacked, straw mulch may be applied at a rate of 1 3/4 ton per acre, and tacked with emulsified asphalt at a rate of 500 gallons per acre.

Wood Fiber Mulch: Typically applied with a hydroseeder at a rate of about 1000 to 1500 pounds per acre, or as a slurry consisting of at least 150 pounds of binder, 400 pounds of wood fiber mulch, and 200 gallons of water per acre.

Requirements

Maintenance: Mulched areas require frequent inspection for damage and deterioration. Requirements will vary greatly based on the type of mulch used and the type of vegetation to be established. Vegetative mulches are usually not intended to be permanent; but are extended only as a base for re-seeding or re-vegetation. Where a permanent anchor for vegetation is required, along steep slopes or areas of higher velocity flows, then a geotextile mat or net is recommended (see ESC20).

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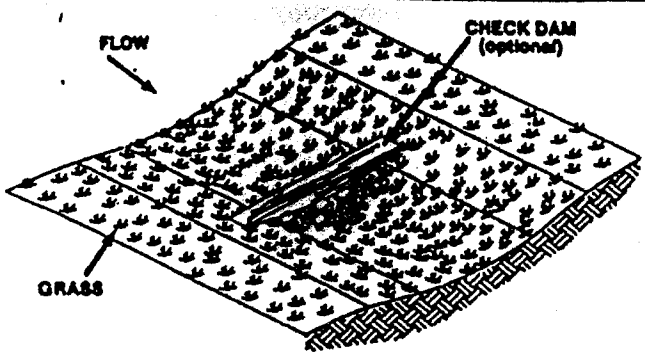
ESC11

BMP: BIOFILTERS



DESCRIPTION

Biofilters are of two types: swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.

EXPERIENCE IN CALIFORNIA

No biofilters specifically designed to treat storm water have been located. However, instances of "biofilter by happenstance" exist in northern communities (Davis, Sacramento, Turlock, Fresno) where storm water is discharged to a grassed area prior to an inlet or an infiltration area.

SELECTION CRITERIA

- Comparable performance to wet ponds and constructed wetlands.
- Limited to treating a few acres.
- Availability of water during dry season.

LIMITATIONS

- Poor performance has occurred but this appears to be due to poor design.
- May be limited to areas where summer irrigation is feasible.
- Can be difficult to maintain sheet flow in strips.
- Can be difficult to avoid channelization in swales.
- Cannot be placed on steep slope.
- Area required may make infeasible on industrial sites.
- Proper maintenance required to maintain health and density of vegetation.

DESIGN AND SIZING CONSIDERATIONS

- The surface area is defined by Figure 4A.
- The minimum width for a swale is determined by Mannings Equation.
- Minimum length of a strip is 10 feet.
- The longitudinal slope must not exceed 5%.
- Use a flow spreader and energy dissipator at the entrance of a swale.
- Good soils are important to achieve good vegetation cover.

CONSTRUCTION/INSPECTION CONSIDERATIONS

- Make sure soils are suitable for healthy vegetation.
- Level cross-section and even longitudinal slope for swales.
- Achieve sheet flow with strips.

Considerations

- Soils
- Area Required
- Slope
- Water Availability
- Aesthetics
- Hydraulic Head
- Environmental Side Effects

Targeted Constituents

- ● Sediment
- ◒ Nutrients
- ◒ Heavy Metals
- ◒ Toxic Materials
- ◒ Floatable Materials
- ◒ Oxygen Demanding Substances
- ◒ Oil & Grease
- ○ Bacteria & Viruses

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training

● High ○ Low

TC4

Best Management Practices

Additional Information — Biofilters

A biofilter swale is a vegetated channel that looks similar to, but is wider than, a ditch that is sized only to transport flow. The biofilter swale must be wider to maintain low flow velocities and to keep the depth of the water below the height of the vegetation up to a particular design event. A filter strip is placed along the edge of the pavement (its full length if possible). The pavement grade must be such as to achieve sheet flow to the maximum extent practical along the strip.

Vegetated biofilters are suitable only for small catchment areas of a few acres, for reasons provided below. Swales are particularly suitable for small residential developments. It may be possible to integrate treatment swales with greenways within large residential developments but each swale should meet the design guidelines presented in this handbook. Strips are most suitable for parking lots in commercial and mutifamily developments. Swales may not function well in residential developments which have open space that remains in native vegetation. Soil eroded from these open spaces may clog the biofilter. Placing a Type 2 catch basin at the upper end of a swale may provide adequate pretreatment. To be effective, the diameter of the catch basin and the depth of the sump below the invert of the outlet should each be at least four (4) times the diameter of the outlet (Lager, et al., 1977).

The performance of biofilters is probably somewhat less than wet ponds and constructed wetlands because the latter provide treatment both during and between storms. Some researchers have observed poor performance, recommending their use only in combination with other treatment control BMPs. However, most field research on swale performance has been conducted on grassed roadside ditches. A swale must be wider than a traditional roadside ditch, to avoid excessive flow velocities which topples the grass and causes channelization. It appears that biofilters can remove particulate pollutants at rates similar to wet ponds and constructed wetlands. The removal of dissolved pollutants may also be similar to wet ponds but less than constructed wetlands. Some researchers have found effective removal of dissolved metals and nutrients whereas others have not.

The swale bottom must be as level as possible; energy dissipation and a flow spreader should be placed at the entrance to minimize channelization. The pavement must be as level as possible along its boundary with a biofilter strip. The pavement edge should be left clear; that is, no curbs. Parking stall blocks must be open to pass the flow as unhindered as possible. Use of curb cuts in curbs is not a satisfactory approach. The cuts channelize the water and can clog with debris. The performance of strips may be compromised by the failure to achieve sheet flow at the interface between the paved area and the strip.

Turf grass is the preferred vegetation. Figure 4B shows recommendations for seven species of turf grass and one ground cover plant for various areas of California (Youngner, et al., 1962). More recent information in this regard is also shown in Figure 4C (CCAE, 1984). Turf grass will require summer irrigation to remain active. Although it has not been tried it may be possible to allow the grass to become dormant during the summer since the biofilter is only in service during the wet season. The biofilter could be irrigated beginning in October to bring it to a healthy condition prior to the first storms. Ground cover species suitable for a non-irrigation situation may work but, it also has not been tried. The soil must be of a fertility and porosity that allows for healthy vegetation. A porous soil also promotes infiltration. See the references that follow for Agricultural Extensive publications on efficient water use by turf grasses.

If erosion of the swale is of concern because of the difficulty of maintaining a good grass cover, consider the use of concrete grids (see Infiltration Systems) or similar material. Another concept is to use check dams to divide the swale into a series of terraces, reducing the longitudinal slope to perhaps 1%, thereby reducing flow velocities.

TC4

Additional Information — Biofilters

Design

Several methods have been proposed to size biofilters (Horner, 1988; FHWA, 1989; IEP, 1991; Tollner, et al., 1976). However, information on the relationship between biofilter area and performance is lacking for urban conditions. Figure 4A uses the method of Horner (1988) with the 2-year storm as the design event, a slope of 3%, and a grass height of 4 inches. A biofilter is sized to treat all storms up to a particular design event. The design event can be relatively small because the aggregate of all small events represents the majority of pollutant runoff. Research in western Washington (Metro, 1992) found that a biofilter sized according to this technique removed 80 percent of the suspended solids and attached pollutants and 50% of the soluble zinc. It was not able to remove dissolved phosphorus or copper.

Figure 4A is meant for guidance only and should be used with caution in areas where precipitation varies greatly because of terrain.

The design engineer must determine the width of a swale using Manning's Equation and the 2-year rainfall intensity (California, 1976) appropriate to the site. An "n" of 0.20 is recommended (Metro, 1992). The design engineer must also calculate the peak flow of the 100-year event to determine the depth of a swale. Since a width using an "n" of 0.20 is generally wider than what is required of a grass lined channel, channel stability should not be of concern. It is generally not necessary to have a bypass for the extreme events because the minimum width specification combined with the relatively gentle slope avoids excessive velocities. If erosion at extreme events is of concern, consider the above concepts to minimize erosion.

The design engineer can make the swale wider than determined in the above step, with a corresponding shortening of the swale length to obtain the same surface area. However, there is a practical limitation on how wide the swale can be and still be able to spread the flow across the swale width. Splitting the flow into multiple inlets and/or placing a flow spreader near the storm inlet should be incorporated into the design. A concept that may work is to place a level 2"x 12" timber across the width of the swale perhaps 10 feet from the pipe outlet. Place gravel between the outlet and the timber, to within 2 inches or so of the top of the timber. Place large rock immediately near the outlet to dissipate the flow energy; the rock also may help distribute the flow. The timber will function like a weir. Flow spreaders have seen limited application and their effect on performance has not been evaluated.

The problem of spreading the flow across the width of the swale may limit its use to tributary catchments of only a few acres. The minimum width based on using Manning's Equation results in widths of 3 to 12 feet per acre of impervious tributary surface, depending on the location and longitudinal slope.

A minimum length of 10 feet is recommended for biofilter strips. Length here is defined as the measurement in the direction of flow from the adjoining pavement. Lengths of 20 to 50 feet have been recommended by most practitioners perhaps because of the concern that sheet flow cannot be maintained. Wherever room permits a length greater than 10 feet should be used. The short length is recommended in this handbook because space is at a premium at most existing industrial sites: 10 feet should work satisfactory if good sheet flow is maintained and no obstructions such as curbs are placed along the pavement edge.

The type of strip discussed here is not to be confused with the natural vegetated buffer strip used in residential developments to separate the housing from a stream or wetland. As the later type follows the natural contour flow channelization is more likely and lengths of 75 to 150 feet are recommended.

TC4

Additional Information — Biofilters

The length of pavement prior to the strip should not exceed a few hundred feet to avoid channelization of large aggregates of runoff along the pavement before it reaches the pavement edge. To avoid channelization, care must be taken during construction to make sure that the cross-section of the biofilter is level and that its longitudinal slope is even. Channelization will reduce the effective area of the biofilter used for treatment and may erode the grass because of excessive velocities.

Maintenance

The facility should be checked annually for signs of erosion, vegetation loss, and channelization of the flow. The grass should be mowed when it reaches a height of 6 inches. Allowing the grass to grow taller may cause it to thin and become less effective. The clippings should be removed.

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TC4

FIGURE 4A. SIZING GUIDELINE FOR BIOFILTERS (SQ. FT./IMPERVIOUS ACRE)

TC4

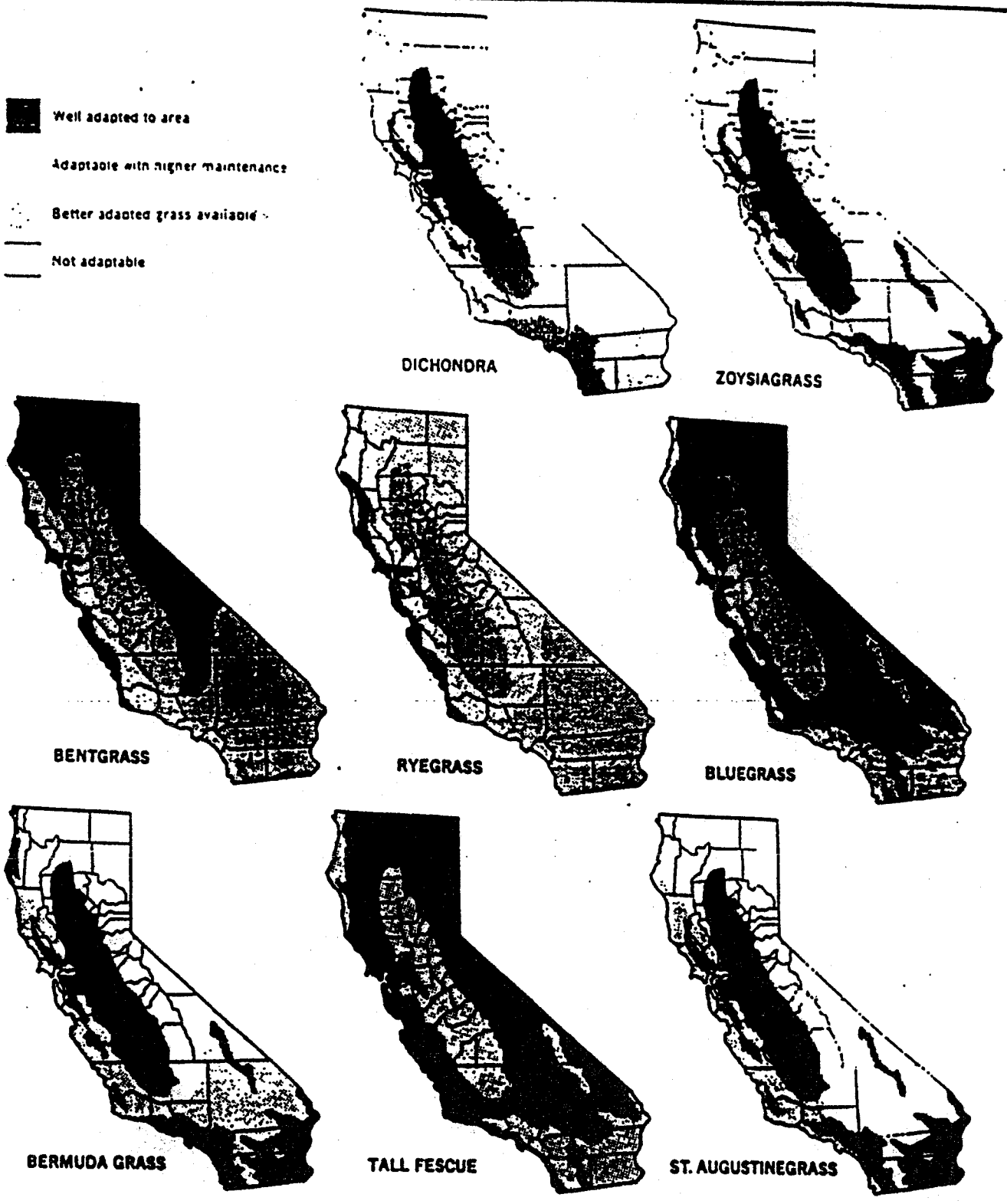

FIGURE 4B. STATE OF CALIFORNIA SHOWING MOST SUITABLE TURF GRASS SPECIES

TC4

COLD TOLERANCE (winter color persistance)

High
- Creeping bentgrass
- Kentucky bluegrass
- Red fescue
- Colonial bentgrass
- Highland bentgrass
- Perennial ryegrass
- Tall fescue
- Weeping alkaligrass
- Dichondra
- Zoysiagrass
- Common bermudagrass
- Hybrid bermudagrass
- Kikuyugrass
- Seashore paspalum
- St. Augustinegrass

Low

HEAT TOLERANCE

High
- Zoysiagrass
- Hybrid bermudagrass
- Common bermudagrass
- Seashore paspalum
- St. Augustinegrass
- Kikuyugrass
- Tall fescue
- Dichondra
- Creeping bentgrass
- Kentucky bluegrass
- Highland bentgrass
- Perennial ryegrass
- Colonial bentgrass
- Weeping alkaligrass
- Red fescue

Low

MOWING HEIGHT ADAPTATION

High cut
- Tall fescue
- Red fescue
- Kentucky bluegrass
- Perennial ryegrass
- Weeping alkaligrass
- St. Augustinegrass
- Common bermudagrass
- Dichondra
- Kikuyugrass
- Colonial bentgrass
- Highland bentgrass
- Zoysiagrass
- Seashore paspalum
- Hybrid bermudagrass
- Creeping bentgrass

Low Cut

DROUGHT TOLERANCE

High
- Hybrid bermudagrass
- Zoysiagrass
- Common bermudagrass
- Seashore paspalum
- St. Augustinegrass
- Kikuyugrass
- Tall fescue
- Red fescue
- Kentucky bluegrass
- Perennial ryegrass
- Highland bentgrass
- Creeping bentgrass
- Colonial bentgrass
- Weeping alkaligrass
- Dichondra

Low

MAINTENANCE COST AND EFFORT

High
- Creeping bentgrass
- Dichondra
- Hybrid bermudagrass
- Kentucky bluegrass
- Colonial bentgrass
- Seashore paspalum
- Perennial ryegrass
- St. Augustinegrass
- Highland bentgrass
- Zoysiagrass
- Tall fescue
- Common bermudagrass
- Kikuyugrass

Low

TC4

FIGURE 4C. ADDITIONAL INFORMATION ON THE SUITABILITY OF TURF GRASS SPECIES